Engineering Library

EDITORIAL

THE demand for safe-deposit boxes suggests the possibility that motorists are using them for the storage of gasoline.

SO far, cities wanting naval bases outnumber slightly those asking for military-supply depots. This, however, may be changed when the returns from the Middle West are received.

DEATH has brought to a sudden end the promising career of John M. Eshleman, lieutenant governor of the State of California. From day laborer to lieutenant governor of the State in a comparatively short time is an indication of the intense nervous energy and steadfastness of purpose that actuated Mr. Eshleman throughout his life. Unfortunately, he was afflicted with a frail body utterly unable to keep pace with the vigorous mentality that produced and placed into execution what is known as the California Public Utilities Act, and made of the State Railroad Commission a power where it had once been almost an object of ridicule. While to a certain extent, the State regulation of public utilities may still be said to be in the experimental stage, nevertheless we believe that in the years to come the value of the work done by Mr. Eshleman will be seen and appreciated in the light of a truer perspective. All California is mourning the loss of one of its foremost citizens.

AS a forerunner of the spring season, labor troubles are becoming manifest. The various brotherhoods of railroad employees, taking their customary initiative, have demanded certain changes in the schedule of wages, and have threatened as an alternative a strike that will tie up practically the entire rail transportation system of the United States, including a part of Canada. The demands of the men amount practically to an increase of 25 per cent in the regular wages and the establishment of an 8-hour day, with an increased rate of pay for overtime. By reason of the character of the work, wages of railway trainmen have been on a mixed basis, in which both hours and mileage are the units for purposes of calculation. Usually a day's pay has been calculated either for ten hours in time or 100 miles in distance, the employee being paid on whichever basis gave the greater return. By reason of the service rendered, it is obvious that the establishment of a definite, fixed 8-hour day, with overtime permitted in case of emergency only, such as is the general rule in other walks of industrial life, is impossible of application for railroad trainmen. If the proposed schedule should be established, it would not prevent the occasional delay in the passage of trains and therefore the hours would be as irregular as they are now. Nevertheless the trainmen would be paid from 25 to 87 per cent more than at present. In fact the entire proposal has little reference to an 8-hour day, however beneficial that might be if it were possible of attainment, but is simply a direct and indirect demand for an increase in wages, and should be considered purely as such by the general public.

IT is not necessary again to direct attention to the fact that the cost of living proceeds merrily upward and that railway trainmen have felt its exactions in common with everybody else. Nevertheless at the present writing an enormous proportion of railway mileage in the United States is in the hands of receivers and more will follow if the demands of the trainmen are granted, unless of course the Interstate Commerce Commission should authorize an increase in freight and passenger tolls that would enable the railroads to meet this new demand upon their revenues. The entire situation reminds us of the see-saw of our schoolboy days, in which one end and then the other goes up, in an effort to bring about a balance. More dollars to the railway trainmen, followed by more dollars for the cost of transportation to the shipper, followed by an increased cost to every individual consumer of every product that has to be transported, simply means an increased income and a proportionately increased outgo whereby the purchasing power of the dollar diminishes as the number of dollars paid in wages increases. As these emergencies arise, the net result to the corporations and to the wage-workers seem no more than a mere marking of time, while the vast body of unorganized workers, the middle class in other words, is being ground between the upper and nether millstones of the corporations on one hand and the trade unions on the other. This sort of affairs directs renewed attention to the hopeless crudity of our entire economic system. We wonder what genius will find a way out, and devise means whereby a greater stability may be brought about for all fields of human endeavor.

The Price of Gasoline

Gasoline is acting like a war baby. In California only a few months ago, 11 cents per gallon was the price at which it could be bought from any of the service stations that dot the landscape. Now it is 18 cents, and the end is not in sight. Those who knew, if they would not admit, that 11 cents was a price at which little if any profit could be made by the refiners, are now trying to resurrect the old-time trust bogie and are shouting for some kind of an investigation. We do not suppose anyone dislikes the peaks and valleys of fluctuating prices

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more than the refiners. These are the sore spots in mercantile life, and keep the management on tenter hooks all the time, trying to guess which way the cat is going to jump, and provide for any condition that may arise.

Those who have followed the production statistics month by month, and compared them with shipments, should be able to hazard a shrewd guess as to the reason for the increase. Then again, there was a storm in the valley oil districts a month or so ago, during which some two thousand derricks were destroyed, and a consequent number of producing wells rendered temporarily idle. So much for the supply phase of the question. Now, as to the demand, consider the automobile. There seems almost no limit to the absorptive qualities of the American people, and no end to the production of what was once the rich man's toy, and now has become every man's friend. The great pacifist of Detroit has returned from Europe with his olive branch and has announced an output this year of 500,000 cars. And so it goes down the line, more and more gasoline being consumed and less being produced. That this state of affairs will stimulate drilling goes without saying, but until production catches up with demand, no relief in prices may be expected.

In spite of the flush production of the Cushing field during the greater portion of 1915, the total output of petroleum was but 1 per cent greater than for the year previous, while the consumption of gasoline increased 27 per cent. There have been no great discoveries of new areas producing light oil, while the decline of production for the Cushing field is making itself felt. New processes, such as the Rittman, will increase the percentage of recovery, while improvements in carburetion will give higher efficiency for internal-combustion engines; nevertheless, these improvements will be slow in making their influence felt to any great degree. However, by way of consolation, motorists, in England, for instance, paid about 40 cents for gasoline before the War. What they are paying now, we don't know. If worst comes to worst, arrange to trade your old heavy car for a new light car, or, better still, try walking. It is fast becoming a lost art.

The Otay Dam Failure

Engineering structures sometimes fail, in spite of the many advances in engineering science and the engineering profession. The collapse of the Otay dam is an instance, and it behooves the profession to draw such benefits as it can from the mistakes that brought about this failure.

As an engineering structure, this dam was unique. Instead of having a concrete, or other impervious face on the upstream side, as is generally customary with dams of the rock-fill type, it had a steel and concrete core-wall in the centre. A full reservoir would bring about a saturation of that portion of the dam on the upstream side of the core-wall, rendering the upstream half incapable of resisting hydrostatic pressure. Here this was particularly true, as no attempt seems to have been made to reduce the amount of voids either by grading the materials or by the exercise of care in placing them.

The most serious error in the design of the dam seems to have been the failure to provide an adequate spillway. The dam was completed two years after the flood of 1895 which gave a run-off of 17,000 second-feet on the adjacent and somewhat similar watershed tributary to the Sweetwater reservoir. Nevertheless, the Lower Otay dam was provided with a waste-way having a capacity, including the outlet tunnel, of only about one-sixth of that amount.

These facts were known to those in charge of the San Diego water system, yet no attempt was made to correct these errors. In addition, zeal to obtain the last possible drop of water seems to have prevented what would appear to have been a most obvious precaution, namely, opening the outlet tunnel. Water commenced flowing through the spillway on January 21, and continued rising during the week, yet the outlet was not opened until January 27. We do not mean to imply that opening the tunnel outlet would have prevented the disaster, but it is not improbable that it might have gained some precious time that could have been used to good effect by residents of the valley. Then again, it was not the city engineer; nor the city manager, an engineer; nor the mayor, also an engineer; but the city attorney who was responsible for the warning sent to the settlers in the valley below the dam. Let engineers remember this when next they feel inclined to criticise the legal profession.

The failure of the Otay dam carries with it some special lessons to those who may be called upon to design and construct such structures in arid regions, for it is in such localities that a dry wash, carrying for years no more than an insignificant trickle of water, may, without warning, become a raging torrent. Here was a dam that had stood for eighteen years, without even calling the spillway into requisition. In the nineteenth year comes the torrential rainfall characteristic of the desert country, and the dam fails. How many dam-structures are there on the Pacific Coast today awaiting the nineteenth year? How many engineers are there whose reputations will be blasted when the unexpected happens?

With the next session of the California State Legislature will come, without doubt, laws of some sort establishing State supervision over the design and construction of dams. Those who will protest against this fresh aggression of the State as an unwarranted interference into private enterprise, will do so without avail. No one nowadays questions the wisdom of the establishment of building ordinances, and why cannot the same process of reasoning be applied to regulation of all other structures involving the conservation of human life? Now, however, no law or laws can restore those who perished in the Otay valley when the dam failed.

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REVIEW OF THE MONTH

THE increase in the price of refined petroleum products is benefiting the producer of crude oil, although not in the same degree. San Joaquin Valley operators are now being paid 53 cents per barrel for oil below 18° Baumé, with a proportionate increase for other grades of oil. The January storms, which destroyed nearly two thousand derricks as well as other structures, assisted in bringing this about, the production being greatly curtailed in consequence. In January, the output of the California fields was even less than that for December, which in itself was notably low. The general demoralization of transportation facilities, by reason of the same storms, resulted in a decrease in shipments, and stocks were not drawn upon to any appreciable extent. The full effect of the storms, however, will not be known until February production statistics are published, for, while reconstruction has been as rapid as possible, it will take some time to replace the destroyed derricks and bring the affected wells back into the ranks of producers.

AS was to be expected, the shortage of crude oil and the increased price of gasoline have had their stimulating effect upon development work. During the week ended February 19, sixteen new wells were reported to the petroleum department of the State Mining Bureau. This is the largest number for any one week since the establishment of the Bureau's department of oil and gas last fall. It should be noted that all but two of the new wells reported are being drilled by the large marketing concerns or their subsidiary companies, outside capital apparently being shy when it comes to investment in California oil properties.

LOVERS of Longfellow will remember "the Druids of eld, with voices sad and prophetic." We have made reference in these columns to the employment by the city of San Diego of a water-witch, divining-rod expert, or what-not, one Mr. C. M. Hatfield, who engaged with the city council of San Diego to fill the Morena reservoir. For this he was to receive $10,000 if successful. Mr. Hatfield has our sympathy for not having obtained a written agreement from the city, the city attorney having failed to find in the statutes of the State of California legal justification for engaging in such a contract with a magician. Lo and behold, however, the January storms put in appearance, willy nilly, and soon there was enough and more water than was required to fill the Morena reservoir. Now Mr. Hatfield wants his money on the claim that he has delivered the goods. He has computed, probably with a slide-rule to several decimal places, that of approximately 10,000,000,000 gallons added to the Morena storage, he is personally responsible for 4,000,000,000, having generously accorded credit to a beneficent Providence for the remaining 6,000,000,000. Thus he concedes to the Creator an efficiency of 60 per cent, while for himself he is satisfied with a mere 40 per cent of credit for his 'pull' with Dame Nature. So far as we can learn, he disclaims all responsibility for the destruction of the Lower Otay dam. The ungrateful city council, however, has declined to make payment, and there is a possibility that Mr. Hatfield may bring suit to make good his claim.

THE influence of the flush conditions in New York is commencing to make itself felt in Pacific Coast financial affairs. This is reflected in an interesting way by the sale of the last block of the original issue of California State highway bonds to a regularly constituted bond-house at par. These bonds bear 4 per cent interest. Since the issue of these bonds in 1910, we have frequently commented in these columns on the fact that 4 per cent interest on a highway bond was not attractive to investors, especially as the law forbade their original sale for less than par. The California State Highway Commission had many difficulties in devising ways and means for the disposal of the bonds fast enough to carry on the projected work, until some genius finally hit upon a plan of disposing of the bonds in blocks to the counties in which the money for road improvements was to be spent. The counties, in turn, were compelled to resell the bonds below par and pocket the loss. In a few cases, public spirited citizens performed the service instead of the county. Fortunately, however, this condition is a thing of the past. The proposed additional bonds which are to be submitted to the voters for approval in November will bear 4½ per cent interest, which should prove sufficient inducement to permit the marketing of the bonds through regular channels.

WE hope that the members of the California State Highway Commission will reconsider their reported decision to resign when funds provided by the original bond issue are exhausted. It is true that there have been attacks of one kind or another upon the Commission from a number of quarters. This, of course, was to have been expected as one of the penalties for holding public office. We believe that the Commission has given excellent, conscientious, and unselfish service to the work, and therefore is entitled to the gratitude of all the people in the State. We do not believe that the angel Gabriel himself could have arranged the main routes for the highways, let alone the laterals, in such a way as to have pleased every voter who was prepared to insist that, wherever else the State highway went, it

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must pass his front door. It is also admittedly impossible for the Commission to have built all of the roads actually needed and up to the requisite standard of first-class construction with the amount of money available. With these two limitations in mind, we cannot see how any reasonable or fair-minded man, or body of men, can find just cause to complain, except for purely selfish reasons. We believe that the Commission has served the people well and it has demonstrated that it is possible for State officials handling public work to obtain 100 cents worth of service for practically every dollar expended.

IN another column we print a map of the proposed laterals which are to serve the mountain counties of the northern part of the State. Highways such as these, which serve districts for the most part without railroad transportation, are for many reasons more important than the main trunk-lines in valleys, which parallel existing railroads. The construction of these laterals and a number of others, as well as the completion of several divisions of the main highways, will depend upon the success of the bond issue that is to be submitted to the people this fall. This bond issue will be much more likely to receive approval if it is known that the administration of the funds will be in the hands of the present Commission, which has demonstrated its fitness for the work in hand.

FROM the condition of dead Caesar 'with none so poor to do him reverence,' to a thing that appears to be really wanted by somebody, is the happy change that has come over the affairs of the Ocean Shore Railway. Hitherto a wall-flower among railroads, there seems to be at least a chance that it may find a partner at last. The identity of those persons back of the gentleman who is busily acquiring options at $47.50 per share, while the market price, if there be a market price, has heretofore been in the neighborhood of $3, is veiled in mystery. To be sure, nothing is being paid for the options, but no one seems to doubt the good faith of the unknown purchasers. About eleven years ago, while the path of railroad promotion was not so strewn with rocks as it is today, the Ocean Shore was started, the idea being to project a road along the shore of the Pacific from San Francisco to Santa Cruz. Construction work made good progress for a while until the San Francisco fire and earthquake brought about difficulties which were soon succeeded by many others. A reorganization was effected in 1910, at which time the bondholders took over the road, but since then it has not been possible to raise funds to carry it to completion. At present about 20 miles is being operated south from San Francisco and the same amount north from Santa Cruz, leaving about half the total distance still unfinished. So far the revenues of the road have been steadily and consistently less than the operating expenses. The San Francisco terminal is undoubtedly valuable property. It is possible that, with the line completed, the Ocean Shore road might be made a useful feeder to some larger system, but even this appears somewhat doubtful.

THE proposed merger of the greater number of California and Mexican oil companies, excepting the Standard and Shell interests, has been abandoned. An enormous amount of preliminary work, including a careful appraisal of the various properties by a corps of experts, has been under way for many months. Now it seems that hopes for the consummation of the plans of the promoters have gone by the board, and the entire scheme is up in the air at present with little hope that it may ever be brought down to earth again, at least for some time to come. The Mexican Petroleum Company and the other Doheny interests, both in California and elsewhere, together with a few lesser companies, have been combined to form the Pan-American Oil Company. Until a short time ago there appeared to be every indication that the Union, Associated, and General Petroleum companies, together with the various members of the Independent Producers' Agency, would also be merged. Unfortunately, however, at almost the eleventh hour that troublesome ghost, the Andrew Weir option, refused to be laid and arose to block the sale of the Union Oil Company, while the promoters, who were engineering the deal, found that it could not be financed. It is to be regretted that the deal could not be consummated. The advantages of combination are many, and in no field of human endeavor are these advantages so pronounced as in the petroleum industry, as is shown by the success of the Standard Oil Company. There are so many loose ends between the geological examination of prospective oil-producing ground and the marketing of the refined products, that proper co-ordination between all of the various elements entering into what is sometimes known as 'the oil game' is essential to success. Had the merger been effected, many economies of administration and production would have been possible; not only that, but real conservation would have been promoted in many ways. As an instance—for some time the Agency has had in its possession more oil than it could sell. As a consequence, a number of wells had to be suspended. It is unlikely that the ultimate recovery of oil in the district in which the suspended wells were situated will be so great as if these wells had been pumped steadily. The Associated Oil Company, on the other hand, has at present more orders than it can fill and in consequence is now compelled to drill more wells. If the two interests had been combined, the drilling of more wells would have been unnecessary, the productive wells of the Independent Agency would not have had to be suspended, and much time and money would have been saved. There is a great deal more to the oil industry than the successful drilling of wells. The transportation, refining, and marketing phases are all parts of 'the game,' and real success is difficult of achievement, except in cases where the oil industry is being handled from one end to the other, from soup to nuts, by a highly developed, trained organization that has every stage under its control from production to delivery to the consumer. It is to be hoped that the merger or something similar may yet be consummated.

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DISCUSSION

Prevalence of Frame Buildings in San Francisco

The Editor:

Sir—You will recall a conversation we had just before I left San Francisco in which I criticised the regulations of the building department which permitted the erection of frame buildings close to the centre of the business district of the city. Two months spent in San Francisco during the Exposition have left me with such a pleasant recollection of the city and its people that I hesitate in making this criticism, and am only doing so because I feel that a note of warning should be sounded, and that restrictions should be put on building construction in order that there shall never be a repetition of the disaster of 1906.

Upon my return to this office I was sufficiently interested to look up the matter and see whether anyone else had made similar observations and like criticism. I find that a member of the National Fire Protection Association, who visited San Francisco during the spring of last year, was similarly impressed by the very flimsy character of many of the buildings put up in San Francisco. I give below a table which I understand is official, giving the amount of money spent in different classes of buildings during the period 1906 to 1914.

Official Building Construction Statistics, San Francisco
May 19, 1906, to Dec. 31, 1914.

Class of buildings.	Number.	Value.	%
Fire resistant	179	$33,455,004	13.5
Reinforced concrete	200	14,807,486	5.9
Brick with wood joints	2,794	82,930,348	33.3
Frame	26,039	98,785,995	39.7
Alterations	24,917	19,036,486	7.6
Total	54,129	$249,015,319	100.00

You will notice the great preponderance of frame structures. No other city in the country would show such a high percentage of buildings of this kind. A member of the National Fire Protection Association, after reviewing the above table, makes the following statement:

"Fuel for another conflagration. A trip to San Francisco today will show cheap, flimsy apartment houses going up in a city which boasts its intelligence and pride."

A further investigation of this subject shows that it has been brought to the attention of Mr. C. Heller, consulting engineer of San Francisco. He comments on the large amount of money spent annually to maintain an extensive and efficient fire department, but states:

"Therefore, if the fire waste in San Francisco is to be further diminished it can only be done by taking better means to prevent the occurrence of fire and not by merely improving methods for their extinguishment."

Better types of construction furnish the means for the prevention of fire. Mr. Heller further comments on the conditions and the criticism which has been made of the character of the buildings when he says:

"The essence of the criticism is that whereas San Francisco spends large sums for fire protection it has permitted an excessive amount of wooden construction, thereby creating an unnecessarily severe fire hazard. * * * There can be little question that by reason of the large amount of money spent in this city in wooden construction the danger of conflagration in the high value district is materially increased, especially because the wooden district is to the windward of the fire limits."

An extract from an article by Mr. Heller, published in the journal of the San Francisco Chamber of Commerce, reads as follows:

"San Francisco spends for fire fighting over one and one-half million dollars a year. For fire prevention it spends nothing!"

With these criticisms by one of your prominent consulting engineers, and by a member of the National Fire Protection Association, I feel that I was entirely right in stating that a note of warning should be sounded so that the conditions might be improved. With experience from your past conflagration, it would certainly seem to point the way to prevention of fires in the future by the construction of buildings of a substantial type and very materially enlarging the fire limits.

Harrison W. Latta.

Philadelphia, February 2.

The Editor:

Sir—In answer to the letter written by H. W. Latta relative to the percentage of frame buildings erected in San Francisco, California, since 1906, I wish to offer the following, based upon long experience in building affairs in this city, and as Chief Building Inspector for the period above mentioned.

In the first place, the quotation from a member of the National Fire Protection Association, "Fuel for another conflagration," etc., does not bear scrutiny, since it is well known that the fire of 1906 caused only a small proportion of loss in the frame-building districts as compared with that within the fire limits, which consists principally of fire-resisting structures, and this notwithstanding the fact that numerous isolated fires were caused in the preserved two-thirds of the city by defective chimneys. These were easily confined and extinguished by the occupants and neighbors in spite of a lack of water following the earthquake and a similar lack of assistance from the Fire Department.

The proportionate use of timber in framing cannot be

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justly compared with other cities throughout the country, since the climatic conditions enjoyed in this locality are peculiarly fitted to such adoption, which is also favored by the recognized strength and durability of the native materials. A trip to San Francisco will show frame residences being built costing all the way from $12,000 to $35,000, and they cannot be justly termed cheap or flimsy.

The Building Law provides amply for the manner and method of all frame construction, and every detail is considered tending both to fire protection and fire resistance.

An impartial reference to the Fire Department records will show that since the establishment of the fire limits no very great conflagration has occurred, other than that caused primarily by the earthquake. It is further generally known that many timid persons prefer a frame residence as a recognized protection against anticipated tremblors.

Mr. Heller's comment on the large amount of money spent annually to maintain an extensive and efficient Fire Department does not do the city entire justice, when it is considered that since the great fire this Department has been so modernized and equipped that 'efficiency' has become its watchword. This naturally entails a proportionate expenditure for its upkeep, and the consequent protection for the city's 400,000 inhabitants.

As a further justification for timber construction, I wish to mention that there has recently been organized a Department of Fire Prevention, which is an auxiliary to the Fire Department. It is composed of the Board of Fire Wardens and is under the direction of the Chief Engineer. This will materially further minimize the fire hazard and there is no extra expense for its maintenance.

JOHN P. HORGAN.

San Francisco, February 23.

Relation of Specific Gravity to Degrees Baumé

The Editor:

Sir—The use of the Baumé scale of gravities for liquids has given considerable annoyance as well as convenience in certain industries. I have had occasion to deal with it in petroleum work, and, not having seen any formulæ published, believe that the figures given below may be of use to some of the operators. A natural and common mistake due to the use of Baumé scale is in the mixing of different gravities of oil to obtain a product of certain gravity on the assumption that the Baumé scale is a direct measure of specific gravity. To illustrate: we have 10,000 bbl. of 16° Baumé oil and wish to know the amount of 25° Baumé oil necessary to add to bring the product up to 20° Baumé. The method of solving by proportion, without converting Baumé to specific gravity easily suggests itself, and the result would be as follows: 10,000 (16) + 25A = 20 (A + 10,000), and A = 8000, the apparent amount to be added. But Baumé gravity is not a direct measure of specific gravity, and specific gravity $= \frac{140}{130 + \text{Baumé gravity}}$

The general form of equation would be $A_s G_s + A_a G_a = G_x (A_s + A_a)$, where A_s is amount of oil at the start; A_a is amount to be added; G_s is specific gravity of A_s: G_a is specific gravity of A_a; and G_x is specific gravity of mixture. Further: let B_s, B_a, and B_x be the Baumé gravities of the oil to start, oil added, and the mixture, respectively; and putting in terms of Baumé,

$$\frac{140\,A_s}{130 + B_s} + \frac{140\,A_a}{130 + B_a} = \frac{140(A_s + A_a)}{130 + B_x}$$

$$\text{Solving, } A_a = \frac{A_s\,(B_x - B_s)\,(130 + B_a)}{(B_a - B_x)\,(130 + B_s)}$$

Using this formula and solving the given problem, the amount to be added is 8493 instead of 8000 bbl. If only 8000 were added the theoretical gravity would be 19.86°, and it might easily result in refusal of purchaser to accept the shipment as 20° oil.

In the consideration of the effect of water content upon gravities, we know that they are lowered unless the gravity of the pure oil is 10° or less. To show the effect of water on specific gravity of oil mixture we can write the equation $G_o(100 - P) + P = 100\,G_m$ and $G_o = \frac{100\,G_m - P}{100 - P}$, where G_o is specific gravity of pure oil, G_m is specific gravity of mixture, and P is the percentage of water. Substituting Baumé degrees for specific gravity and letting B_o and B_m equal the Baumé gravities of pure oil and the mixture, respectively, the result is

$$\frac{140}{130 + B_o} = \frac{\frac{14000}{130 + B_m} - P}{100 - P}$$

$$\text{Solving, } B_o = \frac{14000\,B_m - 10\,P(130 + B_m)}{14000 - P(130 + B_m)}$$

H. W. BELL.

Coalinga, California, February 15.

Control of Water-Power

The Editor:

Sir—I write to ask your help to defeat a most serious attack on our public resources. Since the fight over the Alaska resources was won there has not been so pressing a threat against the conservation policy as the present effort in Congress to give our public water-powers for nothing into monopolistic control.

The Shields bill, now before the Senate, gives to the power interests without compensation the use of water-power on navigable streams. The amount of water-power these streams will supply is larger by far than all the power of every kind now in use in the United States. It pretends to, but does not, enable the people to take back their own property at the end of 50 years, for in order to do so under the bill, the Government would have to pay the unearned increment, and to take over whole lighting systems of cities and whole manufacturing plants. Private corporations are authorized to seize

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upon any land, private or public, they choose to condemn.

Bills which gave away public water-powers without due compensation were vetoed by President Roosevelt and President Taft. The Shields bill would do precisely the same thing today.

Another water-power bill, the Ferris bill, relating to the public lands and national forests, was in the main a good bill as it passed the House. As reported to the Senate it encourages monopoly by permitting a corporation to take as many public water-power sites as it may please. Under it the corporations could not even be kept from fastening upon the Grand Canyon, the greatest natural wonder on this continent. This bill takes the care of water-powers on national forests from the experienced and competent Forest Service, and gives it to the Interior Department, thus entailing duplication and needless expense.

In my opinion, there is undue carelessness as to the disposal of public resources at present in Washington. The water-power legislation now before the Senate is too favorable to the men who, as Secretary Houston's admirable recent report shows, control through 18 corporations more than one-half of the total water-power used in public service throughout the United States. The water-power men charge that Conservation hampers development. The Houston report shows, on the contrary, that the most rapid development is in the national forests, where conservation is best enforced. On the other hand, 120 public-service corporations own and are holding undeveloped and out of use an amount of water-power equal to four-fifths of all there is developed and in use by all the public-service corporations in the whole United States.

As I said in an open letter of January 29 to the President: "Natural resources lie at the foundation of all preparedness, whether for peace or for war. No plan for national defense can be effective unless it provides for adequate public control of all the raw materials out of which the defensive strength of a nation is made. Of these raw materials water-power is the most essential, because without electricity generated from water-power we cannot manufacture nitrates, and nitrates are the basis of gunpowder. There are no great natural deposits of nitrates in the United States as there are in Chile. It would be folly to allow the public water-powers, which can supply this indispensable basis of national defense, to pass out of effective public control."

A concerted movement is on foot to break down the conservation policy. Feeble resistance or none at all is being made by official Washington. Unless the press and the people come to the rescue, the power interests are likely to win. This is a public matter wholly removed from political partizanship. Your help is needed, and that of your paper. For nearly ten years this fight for the public water-powers has gone on. We ought not to lose it now.

GIFFORD PINCHOT.

Milford, Pa., February 15.

Check Dams for Flood Control

The Editor:

Sir—Regarding the use of check dams for flood control, we find, by comparing flood marks on Haines canyon with the Little Tujunga, Cook's canyon, and the general flow of Verdugo creek, that there was a pronounced minimizing effect on the crest of the flood by Haines Canyon structures. You will readily recognize that there are many uncertain factors in any comparison of different watersheds in different storms, and we do not feel that we have sufficient data before us to say definitely just what the result in any given case will be from the expenditure of money in building check dams. We do know that it will help considerably and in addition we have every reason to believe it will double the low-water irrigation supply where the conservation work of this character is thoroughly done. Some of the best illustrations in the past storm have been in little ravines having only a few acres and treated with structures, in one case not costing quite $0.80. From water measurements made during the January storm of two canyons of approximately the same area and length, the treated ravine discharged only one-sixth as great a flood crest as the untreated one. The treated ravine had sixty dams which cost $47.00, and the rancher who installed them is enthusiastic over the result.

Western Empire ravine, one of the laterals of Haines canyon, at no time during the past winter has had any surface discharge at the mouth of the canyon. There are twenty-two acres in this watershed, and the whole canyon is now fairly waterlogged. Of course there is water running in the boulder-cone at the mouth of the canyon underneath the surface, but neither now nor at any time for two years has there been a drop of surface water reaching Haines canyon from Western Empire ravine. I account for this by assuming that the water drops over the last dam so clear and free from slime and silt that it at once enters the porous ground and sinks out of sight.

There is some opposition to the plan of voting a large sum of money to install these check dams generally throughout the mountain district of Los Angeles county, but I think the opposition is diminishing and that the first money voted at all for flood control will be for this particular class of work.

Frank H. Olmsted.

Los Angeles, February 23.

Concrete-lined sunken reservoirs for oil storage are to be substituted for steel tanks at the Navy Yard at Mare Island, California. The particular reason for this change is that besides being more permanent, the reservoirs are virtually bomb-proof. An enemy aviator would have great difficulty in dropping explosives on the reservoirs and even should he succeed, but little damage would be done, while both tanks and contents would probably be a total loss if hit.

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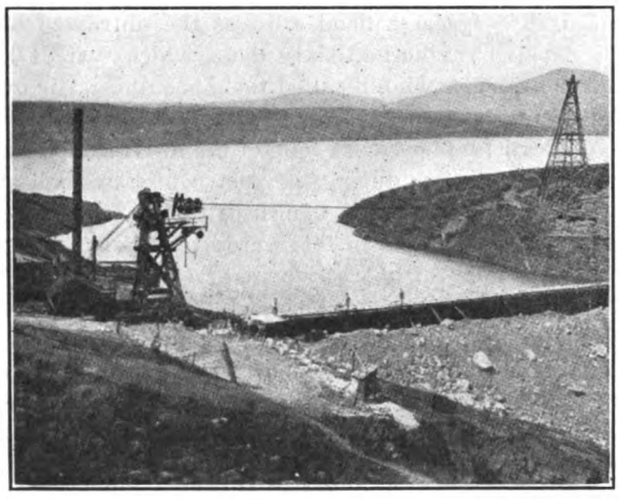
Failure of the Lower Otay Dam*

During January two severe storms visited southern California in general and San Diego county in particular, resulting in considerable destruction of property, and culminating in the failure of the Lower Otay dam. This dam was built by the Southern California Mountain Water Co. and was completed in 1897. The reservoir, together with the Morena, Barrett, and Upper Otay reservoirs form the collecting portion of the water system by which the company supplied the City of San Diego, and which was later taken over by the City itself.

The dam was a rock-fill structure with a steel core-wall. It was 130 ft. high and 565 ft. long on the crest. The total capacity of the reservoir was about 14,000,000,000 gallons. The original plans called for a solid masonry dam. A trench was excavated to bedrock and the structure was carried to a height of 28 ft. under



VIEW OF DAM WHEN NEARLY COMPLETED.

these designs. The plans were then changed and a rock-fill dam selected. The core-wall was composed of steel plates, ranging in thickness from No. 0 to No. 3 Birmingham gauge, and either 5 by 17 ft. or 8 by 20 ft. long. These plates were riveted together in place, calked, and covered with asphaltum. The bottom of the steel wall was embedded in the masonry portion of the dam and the steel was protected by a concrete wall, 1 ft. thick on each side of the plates. During construction it is stated that the steel core was frequently carried several feet above the concrete, and the consequent warping from expansion in the summer sun threw it considerably out of alignment at a number of points. The rock for the fill was a hard porphyry, brought by a cableway from a quarry just below the dam. Examination of the small portion of the dam still remaining on the sides of the canyon shows that the fill was mainly composed of comparatively small pieces ranging in size from 1½ ft. in diameter down to coarse gravel. The photographs taken during the construction show that there was no attempt to reduce the voids either by selection of material or by methods of placing. Opinions differ as to the slope actually assumed by the fill, but it seems probable that it was between 1:1 and 1¼:1 on both faces. No attempt was made to render the up-stream face watertight, reliance being placed solely upon the core-wall. There was some leakage through the dam, however, and this was said to amount to approximately 225,000 gallons per day in the fall of 1915. A small pump was used to return this to the reservoir. There seems to be some doubt as to whether or not any part of the dam-site was stripped to bedrock except the portion under the masonry, but it is probable that this was not done, and that the rock fill was placed directly upon the soil at the bottom of the canyon.

The spillway was on the east bank and was about 40 ft. wide. Its bottom was 8 ft. below the top of the dam. Its estimated capacity running full, was 2400 cu. ft. per second. The only blowoff provision was by means of the outlet tunnel, which was 4 ft. in diameter, and about 1100 ft. long. The capacity when discharging under the head of a full reservoir was 400 cu. ft. per second, making the total possible capacity for relieving the dam about 2800 cu. ft. per second. The drainage area tributary to the reservoir was approximately 100 square miles. Since records have been kept on this watershed there have been no very high runoffs, but during the famous 1895 flood, the runoff on the nearby Sweetwater watershed was estimated at 17,000 cu. ft. per second. The two watersheds have approximately the same area and somewhat similar climatic conditions.

Since the completion of the dam, the reservoir was never filled until just before the dam failed. The first storm lasted from January 15 to 20, the total rainfall at the dam-site during this period being 5.60 in. The second storm lasted from January 25 to 27, and 3.54 in. of rain was recorded at the dam-site. The water commenced running through the spillway on the morning of January 21 and continued to do so until the dam failed. In spite of the fact that the water continued to rise, the gate in the outlet tunnel was not opened until about noon on January 27. The water continued to rise during the afternoon. About this time, City Attorney Cosgrove of San Diego became alarmed by the steady rise in the reservoir, and called the mayor, city manager, and city engineer into conference. As a result of this conference, warning was sent to the residents of the

*Staff article; photographs taken from reports issued by the United States Geological Survey.

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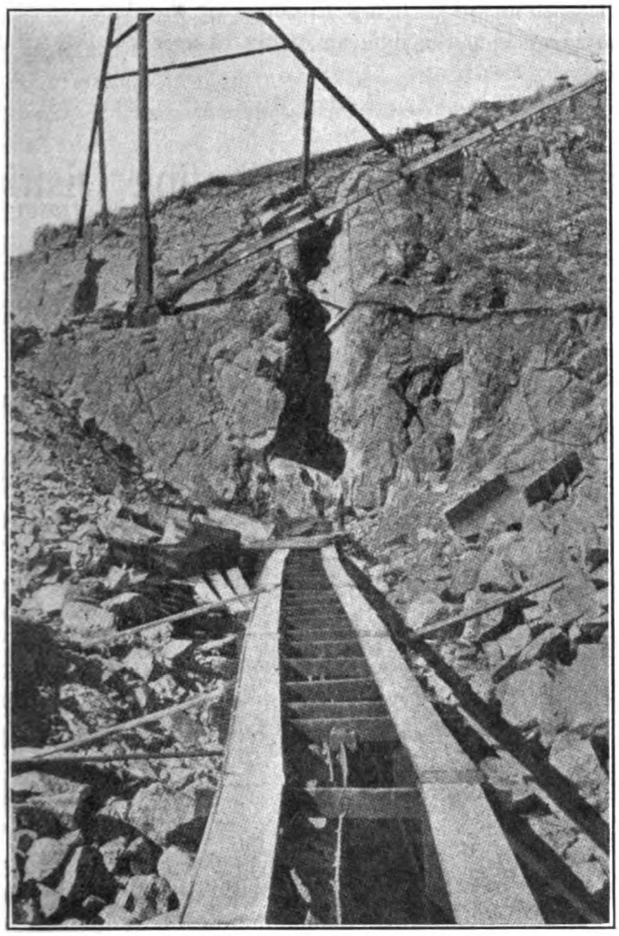
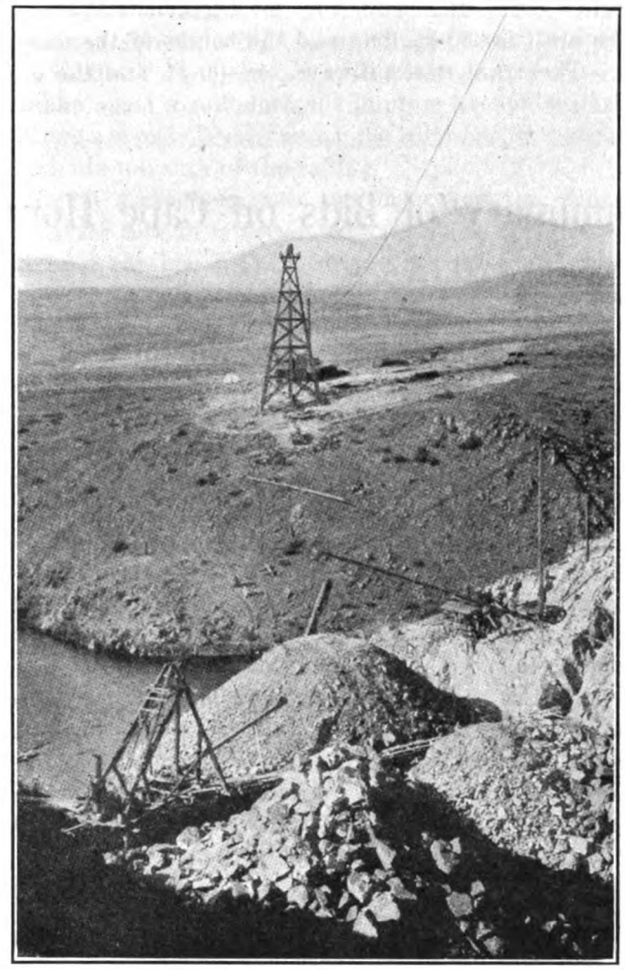
valley below the dam to fly for their lives to higher ground. It is probably due to Mr. Cosgrove that the loss of life was comparatively small.

There was two or three feet of earth fill above the top of the steel core. The water reached the elevation of the top of the core about 4 p. m. and commenced to seep through to the downstream face. Failure did not commence until about 5 p.m., when the water began to flow over the top of the dam. There is some uncertainty as to the height to which the water finally rose, but it was probably only a few inches above the crest of the dam. This was, however, sufficient to cause the fill on the lower side of the core-wall to disintegrate rapidly. About fifteen minutes after the dam was topped, so much of the supporting fill had been removed that the steel core gave way under the tension. Failure occurred about the middle of the structure, the two halves of the core opening out like a pair of gates. About two hours and a half were required to empty the reservoir.



METHOD OF CONSTRUCTION OF CORE-WALL.



CABLEWAY USED FOR DEPOSITING FILL.

The released water swept down the narrow canyon, carrying everything before it. A heavy growth of brush along the sides of the canyon was removed along with every scrap of soil, it being possible to trace the high-water mark of the flood by following the exposed bedrock down the canyon. Fragments of the steel core were carried downstream, in some cases for as much as ten miles. The plates were in good condition, and showed no signs of corrosion during their 19 years of service.

Exaggerated reports of loss of life were published immediately after the disaster, but the coroner states that the known dead do not exceed 14. It is probable that these were all persons who could have escaped had they sought safety immediately upon being warned. The property loss has been estimated at $250,000, but it is doubtful if this allows for the complete destruction of the productive capacity of the farms in the valley below the dam, where the soil was entirely removed, even the bedrock being exposed.

It was feared for a time that other dams in the same region might fail. The Morena dam is also part of the collecting system for the city water supply. It is a rock-fill structure, 150 ft. high, having a concrete face on the up-stream side. So much debris was brought into the reservoir by the flood as partly to choke the spillway. The water in consequence rose to within 18 in. of the top of the dam and there was sufficient wave-action to carry drift over the top. Prompt action in opening all the outlet gates and in clearing drift from the spillway brought the water down below the danger-

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point. Further evidence that the safety of the dam was threatened is furnished by the fact that the rock-fill settled a few inches and moved down-stream a similar amount.

The Upper Otay dam, also a part of the city system, is a reinforced concrete arched structure, 84 ft. high. The runoff from its watershed, whose area is about 20 square miles, was particularly heavy. At the peak of the flood, 3 ft. of water flowed over the top of the dam. No damage was done, although the judicious use of sand-bags was all that saved an earth fill near one end of the structure.

The Cuyamaca dam is an earth-fill structure with a puddle core. It is owned by the Cuyamaca Water Co. The crest is 635 ft. long and the height of the dam 41 ft. There are two spillways, one 90 ft. and the other 41 ft. wide. In spite of the fact that a large quantity of water had been drawn off between the two storms, the water reached a point 14 in. below the top of the dam, both spillways flowing 4 ft. deep. No damage was done to any part of the structure. A portion of the conduit leading from the dam to the City of San Diego was washed out, but this was soon repaired.

The Sweetwater dam is a masonry structure and is owned by the Sweetwater Water Co. At the peak of the flood, in spite of the spillway flowing full and the blow-off valves being open, water flowed over the top of the dam to a depth of 3.5 ft. This washed away an earth fill at one end of the structure and ruptured the concrete core-wall. An opening about 75 ft. wide was made in this way and the material washed out to bed-rock, about 30 ft. below the crest of the dam. A short distance from the dam an earth fill across a low saddle was also destroyed.

Summary of Bids on Cape Horn Tunnel, Oakdale Irrigation District

One of the most important contracts recently awarded in California was for the construction of Cape Horn tunnel, part of the irrigation system of the Oakdale irrigation district, in Stanislaus county. The tunnel is to be 7200 ft. long, and is to be egg-shaped, 7 ft. wide and 8 ft. high. It is to be lined with concrete where considered necessary by the engineer. The specifications require caution in the use of powder, and the district will pay for unavoidable overbreakage only. Payment for concrete lining is to be made on the basis of the quantity between the lines, except in the case of unavoidable overbreakage. The contractor is to be allowed to sink two shafts 7 ft. square. Payment for the excavation of these shafts is to be made on the same basis as that within the tunnel.

The contract included the construction of a hydraulic fill dam 200 ft. long on the crest with a maximum height of 25 ft. The material is to be deposited near the outer slopes, the crest of the deposits not to exceed 15 ft. wide and the centre to be filled with water to a line 3 ft. below the top of the deposits. The dam is to be faced with concrete, which is to be amply reinforced with clinton mesh fabric.

The contract also included the construction of a canal 10 ft. wide on the bottom and 8 ft. deep for a distance of 132 ft. from the west end of the dam to the present canal. Concrete for all the work is to be a 1:2:4 mixture, either gravel or crushed rock to be used for coarse aggregate. Machine mixing is specified and the concrete is to be wet enough to run slowly and to fill the forms with no other assistance than shoveling. Concrete is to be kept wet for three days after being placed, and shaded for a week thereafter.

Plans for the work were prepared by Burton Smith, engineer for the district. Bids were opened on January 17 and the contract awarded to James Willison, of Turlock. The quantities were 11,250 cu. yd. tunnel excavation, 3646 cu. yd. open-cut excavation, 580 cu. yd. plain concrete, 185 cu. yd. reinforced concrete, and 7346 cu. yd. puddle fill. The unit prices per thousand feet B.M. for lumber, and per cubic yard for the other materials were as follows:

Contractor.	Tunnel excavation.	Reinforced concrete.	Open-cut excavation.	Puddle fill.	Plain concrete.	Timber per M.B.M.	Total.
Seabury B. Peterson	$5.00	$24.55	$0.30	$0.45	$17.00	$60.00	$75,051.25
Charles H. Warren	6.90	13.50	0.40	0.45	10.50	39.00	90,976.60
G. H. Kilbeck	6.00	20.00	1.00	0.75	18.00	32.00	90,795.00
Tibbits-Pacific Co.	6.60	18.00	0.66	0.66	18.00	60.00	95,274.72
Bates, Borland & Ayer	6.35	15.00	0.80	0.60	14.00	55.00	89,656.00
Twohy Bros.	4.50	20.00	0.40	0.50	10.00	70.00	66,381.40
A. C. McLean Co.	6.40	22.00	0.40	0.50	25.00	46.20	95,701.00
Collman & Collman Co.	11.90	14.00	0.60	0.50	13.00	60.00	149,865.60
A. Blumencranz	5.90	18.50	0.60	0.40	16.50	40.00	84,493.50
Pacific Coast Construction Co.	4.35	15.50	0.50	0.50	15.50	50.00	66,291.00
James Willison	3.49	15.00	0.65	0.50	15.00	40.00	56,780.00
J. H. Clark	4.25	14.00	2.00	0.50	20.00	75.00	72,967.00
Ross Construction Co.	5.60	15.00	0.35	0.50	15.00	70.00	79,424.10
W. F. Gerdetz	5.70	18.00	0.75	0.75	16.00	45.00	84,979.00
Healy-Tibbetts Construction Co.	6.20	18.00	1.25	0.55	20.00	55.00	93,277.80

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Approved Practice in Concrete Highway Construction

The National Conference on Concrete Road Building was held at the Auditorium Hotel in Chicago, February 15-18. Below follows an abstract of the reports presented by some of the more important committees.

Drainage and Preparation of Subgrade. This Committee was composed of Hector J. Hughes, professor of civil engineering at the Massachusetts Institute of Technology, chairman; Clinton Cowen, Ohio State Highway Commission; George W. Cooley, engineer for Minnesota State Highway Commission; George A. Quinlan, superintendent of highways, Cook county, Illinois; and Edward T. Beck, contractor of New York. The committee in its report, emphasized the importance of adequate drainage, but called attention to the fact that some engineers believe that where perfect drainage is hard to secure, it is often cheaper and better to reinforce the pavement sufficiently to withstand stresses caused by frost action or similar movements, rather than to take additional precautions about drainage.

Not only should all trees and undergrowth be removed from between the slope-stakes, but also, in the case of shallow embankments, grass or decayed vegetable matter should not be permitted to remain, as they tend to prevent adhesion of new material and are likely to cause soft spots. Grubbing should be done for the full width of the excavation. Roots and stumps should be removed from the drainage ditches and wherever they will interfere with underdrains, as well as under embankments so shallow that the decay of roots or stumps might cause settlement. The custom of not requiring grubbing for fills over five feet is condemned. So much depends upon the soil, size of stump, and other local conditions that this question should be left to the judgment of the engineer and provision for payment made accordingly.

Four types of cross-section for the subgrade are in use. First, crowned parallel to the wearing surface; second, crowned somewhat less than the wearing surface, which is thus made thicker at the centre than at the sides; third, subgrade flat; fourth subgrade lower at the centre than at the sides. Recent practice seems to favor the last two types as being better able to resist the tendency to shrinkage-cracks as well as to withstand heavy loads. Recommendations regarding side slopes, balancing of cut and fill, etc., are similar to standard practice on railroad work.

After removal or destruction of perishable matter, the surface under new embankments should be roughened wherever the new material is likely to slide. Benches should be cut on side-hill slopes, and on the sides of old embankments. New earth should be deposited and rolled in layers one foot thick or less, depending upon the character of the soil. On most soils, a roller weighing ten tons or more should be used, but in some cases better results are obtained with a lighter machine. The embankment should be kept slightly moist during rolling. Until the earth has settled for at least one season, it is not desirable to build a concrete surface on any but the shallowest fills, even if thoroughly rolled. Where the subgrade is an old road surface of gravel, broken stone, or earth, it is usually necessary to loosen the old material and re-roll it. Certain clay soils can be rolled only when covered with a layer of sand, gravel, or dry, loose earth. In some instances straw or similar material may be used to facilitate rolling. Where drainage trenches are to be placed under the subgrade, this should be done in advance of the rolling.

In general, keeping the water away from the roadbed by surface ditches is better than removing it afterward with underdrains. Where drains are necessary, pipes laid in trenches and covered with coarse gravel or similar filling are to be preferred to pipes covered with the excavated material from the trench, or to 'blind drains.' No pipe should be less than four inches in diameter. Drains should be laid at least 2½ to 3 ft. below the subgrade, and 4 ft. is often better. Usually the best arrangement for drains in trenches is to have either one line parallel to the centre line of the road on the side from which the underflow comes, or else one line on each side. Sometimes it is better to have a succession of transverse drains laid at a sloping angle across the road. For wet foundations, a combination of the two systems is often advisable.

Problems of Design, Thickness, Crown, and Grade. This committee was composed of Ira O. Baker, professor of civil engineering at the University of Illinois, chairman; T. H. McDonald, engineer for the Iowa State Highway Commission; H. L. Bowlby, formerly state highway engineer of Oregon; E. W. Stern, engineer of highways for the Borough of Manhattan, New York City; and R. C. Hunt, an Ohio contractor. No general rules can be laid down for the thickness of a concrete pavement. Leaving out questions of the quality of design and workmanship, the thickness should depend upon the climate, the character of the soil, and character of the traffic, the drainage, and the width of the slab. Approved practice varies between the 4-in. thickness of slab used in the mild and semi-arid climate of California to pavements 7 or 8 in. thick in the Mississippi valley.

The crown of a country road should be less proportionately than that of a city street. The crown may also be smaller in an arid than in a humid climate. A crown of 1/100 of the width of the pavement is recommended for country roads.

The maximum grade permissible is dependent upon the climate, the character of the traffic, and the finish of the surface. Making the surface grooved or corru-

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gated renders it less slippery, but weakens the slab. Roughly speaking, grades of 10% are permissible in arid regions, while 6% should seldom be exceeded where the climate is humid.

Organization of Concreting Crew. This committee was composed of H. P. Gillette, editor of *Engineering and Contracting,* chairman; E. I. Cantine, engineer for the Oregon State Highway Commission; W. F. McVaugh, engineer of Madison county, Indiana; Walter Buehler, a Minnesota engineer; and O. T. Dunlap, an Illinois contractor. Most delays are caused by lack of materials at the mixer or by failure of the water-supply. On a job of any size, it is usually a good plan to have a man at the sources of supply for materials, to see that the manufacturers live up to their contracts and that the railroads furnish cars. To allow for delays in delivery it is advisable to conduct the work so as to have materials delivered along the road at least one mile in advance of the mixer. A duplicate pump is a good thing to have in case of a breakdown of the water system. A skilled mechanic should be employed to repair the various parts of the construction plant and besides the ordinary blacksmith tools, he should be supplied with some of the commoner machine-shop equipment.

The subgrade should be graded roughly with a road machine, being left an inch or so higher than the final grade. The wooden side-forms are then set. Then a grader is used to bring the subgrade to about ¾ in. above the final grade, the excess earth being removed with a two-horse fresno scraper. The subgrade is then moistened and rolled lightly. The next step is to scarify the subgrade to a depth of about 2 in., using a 'gang-rooter' plow drawn by a roller. If the soil is hard clay, the clods should be broken with a disc-cultivator. The final touch is given with a 'grading templet' such as is shown in Fig. 1, drawn by a team. The subgrade is then

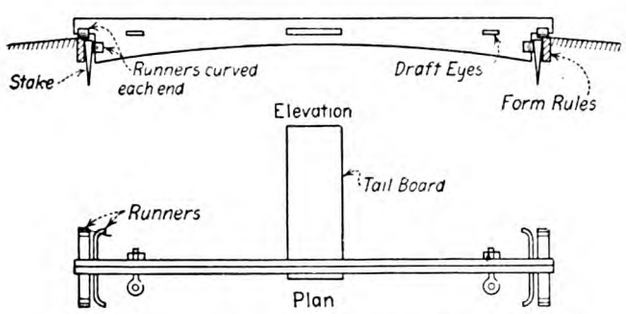

FIG. 1. GRADING TEMPLET FOR PREPARING SUBGRADE.

sprinkled and rolled. A 'checking templet' of similar design to the grading templet but with nails 3 in. apart, projecting 1 in. below the bottom may be used. This will ensure that there will be neither waste nor thin spots in the concrete.

A pipe-line for conveying water to the work is a necessity and many contractors find that it pays to have two parallel lines, one for the mixer only, and the other for wetting the concrete, camp supply, and other uses. A good size for the pressure-pump is 4 by 6 in., working at a pressure of 350 lb. Such a pump will deliver 50 gal. per minute through a 2-in. line five miles long against 250-ft. static head, or further if the head is smaller. A pump like this needs to be operated 12 or 14 hours a day to supply the mixer and wet the concrete and the subgrade. After 2-in. pipe has been strung along the road, four men will lay 1000 to 1500 ft. of new pipe in a day or 600 to 800 ft. of old pipe with somewhat battered threads.

The output of a given number of men in a concrete crew is dependent mainly on the placing of the material, the experience of the men, the width of streets, obstructions, such as car-tracks, and the character of the subgrade. Many contractors prefer to arrange their crews so that one set of men loads the barrows and another set does the wheeling, the two sets changing off occasionally during the day. The wider the street, the more concrete can be laid in one day. One contractor found, in the course of a year's work, that his average daily yardage on a 13-ft. pavement was 600, increasing to 950 sq. yd. on a 30-ft. pavement. Nevertheless, it has been found by experience that it is not economical to diminish the size of the gang for a narrow pavement. Where there are car-tracks the output of a gang will be considerably reduced, usually about 25%. If the subgrade is soft so that planks are necessary for runways, the amount of concrete laid will be reduced. No change in the size of the gang is advisable on account of this, except perhaps one extra man to move the wheeling-planks.

The following is the gang arrangement used on highway construction in Milwaukee county, Wisconsin: one foreman, one timekeeper, one engineer, one fireman, one pumpman, one form setter, one finisher, two strike-off men, two puddlers, two men handling cement, one waterboy, one man bundling sacks, six men handling sand, twelve men handling rock, one man removing forms, two men covering concrete, one man sprinkling, and one man trimming subgrade, a total of 38 men. The total payroll was $89 per day. The pavement was 18 ft. wide and 7 in. thick on an average. The subgrade was clay and required little sprinkling before laying the concrete. Wheelbarrows were run directly on the subgrade without planks. Sand and gravel were placed in the middle of the road and cement on the side. Water was available at the work and was pumped through 2-in. pipe by a steam-pump. A 16-ft. paving mixer was used with an open spout for distributing the mixed material. A 1:2:3½ mixture was used. Protected joints were placed every 50 ft. The maximum output for one day was 1000 sq. yd., the minimum 264 sq. yd., and the average 665 sq. yd. The actual labor cost to the contractor for mixing and placing was $0.14 per cu. yd. Adding $0.02 per cu. yd. for lost time, moving plant to and from the job, laying pipe-line, etc., makes $0.16 per cu. yd. for the total labor cost of laying the concrete.

Position and Construction of Joints. This committee was composed of G. A. Ricker, former deputy commissioner for the New York State Highway Commission,

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chairman; H. J. Kuelling, highway commissioner, Milwaukee county, Wisconsin; F. C. Smith, an Ohio consulting engineer; E. D. Boyer, engineer for the Atlas Portland Cement Co.; and A. W. Summers, a New York contractor. It is recommended that joints be so placed that as nearly as convenient the length of the slab should be three times the width. For road pavements, joints should be placed from 25 to 50 ft. apart. For street pavements 50 ft. wide and over, transverse joints should be placed not more than 25 ft. apart. They should be placed at right angles to the centre line and should be not less than ¼ in. or more than ⅜ in. wide. Where curbs are used, a longitudinal joint not less than ¼ in. wide should be placed between the curb and the pavement. All joints should extend through the pavement, and should be constructed in a plane perpendicular to the surface. Protection of transverse joints by metal plates is not recommended.

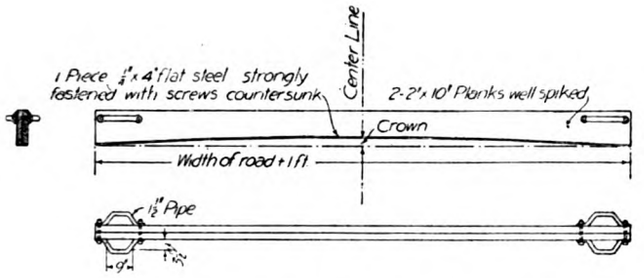

FIG. 2. STRIKEBOARD FOR NARROW PAVEMENTS.

Finishing and Curing. This committee was composed of Charles W. Baker, editor of *Engineering News*, chairman; W. A. McLean, engineer of highways for Ontario, Canada; H. M. Sharp, deputy state highway commissioner, Columbus, Ohio; W. M. Kinsey, engineer for Universal Portland Cement Co.; and H. W. Underwood. Where the pavement is 20 ft. wide or less, a board such as is shown in Fig. 2, may be used for 'striking off' the concrete. The board rests on the side-forms and is moved forward with a saw-like motion. If at any time this does not produce a uniform surface, the board should be moved back and additional concrete spread with a shovel, and the board moved forward again. The ideal consistence of concrete for road construction is such that the concrete can be struck off with the least amount of work. Except near joints, the striking is done in the direction in which the work is progressing. When the board comes to within one foot of a joint, it should be lifted, placed at the joint, and worked away from it.

This same type of strike-board can be used for street pavement more than 20 ft. wide, but lateral bracing will be required. Where a good deal of wide pavement is to be laid, a board such as is shown in Fig. 3 may be used. On streets with level grade, the crown is often increased from the summits to the inlets. This makes it impossible to use a strike-board that travels on the curb or the side-forms. Fig. 4 shows a method of striking off the concrete in such cases. Stakes are driven along the centre line of the pavement about four feet apart before placing the concrete. The top of the stake should be 2 in. above the surface of the finished pavement. After the concrete is placed, a 2 by 4-in. timber is nailed to the top of the stakes. A strike-board a little longer than one-half the width of the street is used, riding the curb and the timber. If the height of the curbs above the gutter-grade is variable, another guide-strip should be

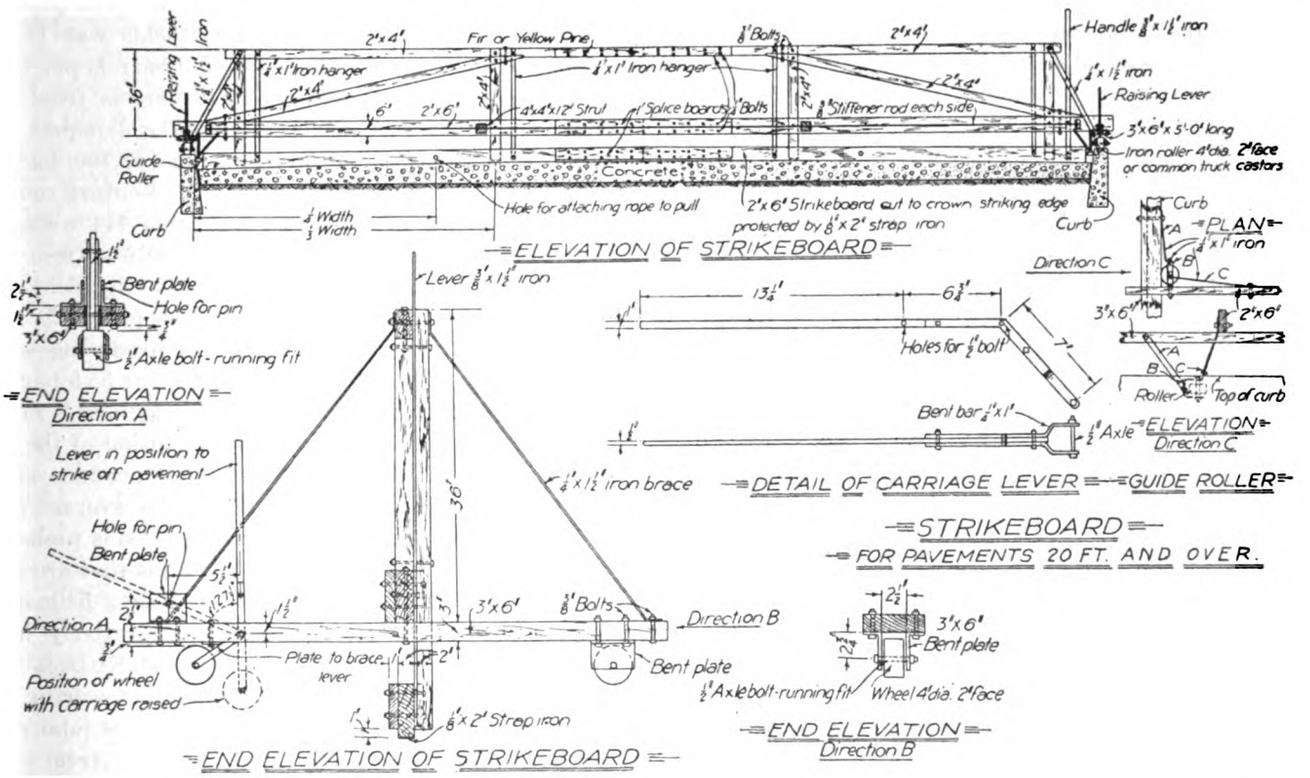

FIG. 3. STRIKEBOARD FOR WIDE PAVEMENTS.

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placed in the gutter. After the striking off is done, the guide-strip and the stakes are removed by men working from a bridge.

The pavement should be finished with a wooden hand-float. When concrete is finished with a steel trowel, the surface is usually too slippery. It is hard to obtain good results with a long-handled wooden float. No definite rule can be given as to the proper time that should elapse between the placing and finishing the concrete. If the weather is hot, the concrete may be finished much sooner than if it is cold or cloudy. The usual tendency is to finish too early. The surface of the concrete should contain practically no free water at the time of finishing and

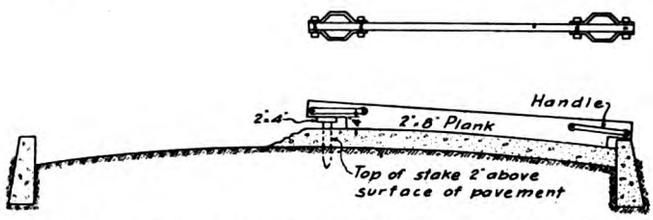

FIG. 4. ARRANGEMENT FOR STRIKING OFF FOR IRREGULAR CURB-HEIGHTS.

should be of such consistence that wood float-marks will show on the surface.

Workmen should not be allowed to walk on the concrete after it has been struck off. The finisher should work from a bridge, such as is shown in Fig. 5. When the bridge is used with curbs that are more than 2 in. higher than the crown of the pavement, the 4 by 4 in. blocks at the end may be omitted.

During hot or windy weather it is advisable to cover the last half-day's work with canvas. The canvas should not touch the fresh concrete but should be supported on frames. Canvas that has been waterproofed is economical because it will not be affected so readily by moisture

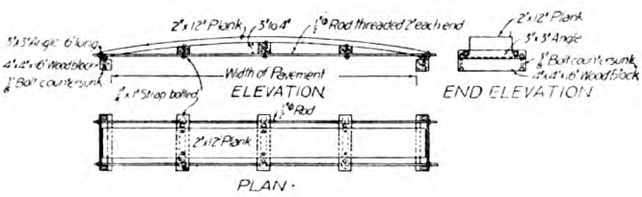

FIG. 5. FINISHER'S BRIDGE.

nor by the destructive action of the cement mortar.

When the concrete has had sufficient time to harden, the canvas should be removed and the pavement covered with earth or other water-retaining material to a depth of about two inches. This covering should be kept wet for from 10 to 14 days. Another method is to flood the pavement with water, retaining it by building banks of earth eight or ten inches high along the sides of pavement, and also transversely where the pavement is on a grade.

When an unexpected storm arises before the concrete has had time to harden, it should be covered with canvas placed on frames. Where there is danger of freezing, the pavement should be covered with canvas the first night, and for several nights thereafter with straw or similar material, enough earth being added to keep the straw from blowing away. Heating the water and aggregate helps to prevent freezing. In no case should concrete be deposited upon a frozen subgrade. Where a severe frost is expected, both straw and canvas should be used to cover the fresh concrete.

During warm weather from two to three weeks is sufficient for hardening the concrete before the pavement is thrown open to traffic. This time should be extended considerably when the weather is cold during the hardening period. It occasionally happens that it becomes necessary to open the highway to light traffic before it is absolutely safe to do so without special precautions being taken. Under such conditions, if about three inches of straw is placed on the pavement and this covered with several inches of earth, the surface will be protected against abrasion. This cover however, will not reduce the danger of damage from heavy loads.

CALIFORNIA OIL PRODUCTION IN 1915

Statistics of production in the various California oil-fields in 1915 as given by the *Standard Oil Bulletin* are as follows: During December 1915, which was a fair average of the year for most of the fields, there were 1684 wells producing in the Kern River field, and the production was 23,340 barrels per day, or an average of 13.9 barrels per well. In the McKittrick field there were 276 wells producing and the output was 8697 barrels per day, or 31.5 barrels per well. In the Midway-Sunset field the daily production was 104,691 barrels from 1418 wells, or 73.8 barrels per well. The production in the Lost Hills and Belridge fields was 11,439 barrels per day from 248 wells, or 45.9 barrels per well. The Coalinga production was 33,248 barrels from 804 wells, or 41.3 barrels per well. In the Lompoc and Santa Maria fields the production was 12,460 barrels from 237 wells, or 52.6 barrels per well. Ventura county and Newhall produced 3215 barrels from 444 wells, or 7.2 barrels per well. The daily production from the Salt Lake field and the old Los Angeles City field was 5236 barrels from 691 wells, or 7.6 barrels per well. The Whittier and Fullerton fields had 613 producing wells with an output of 34,037 barrels per day, or 55.5 barrels per well. The showing from the Salt Lake field is lower than it should be, on account of the inclusion of the old City field, whose wells probably do not produce more than a barrel per day on an average. The average production from the Salt Lake wells themselves is probably around 15 barrels per day. The 112 wells that are still being pumped at Summerland produce only a little over a barrel per day per well. The comparatively high average production per well in both the McKittrick and the Santa Maria and Lompoc fields is noteworthy, as there are few new wells in these fields. The total production from the State was 236,593 barrels from 6532 wells, or 36.2 barrels per well per day.

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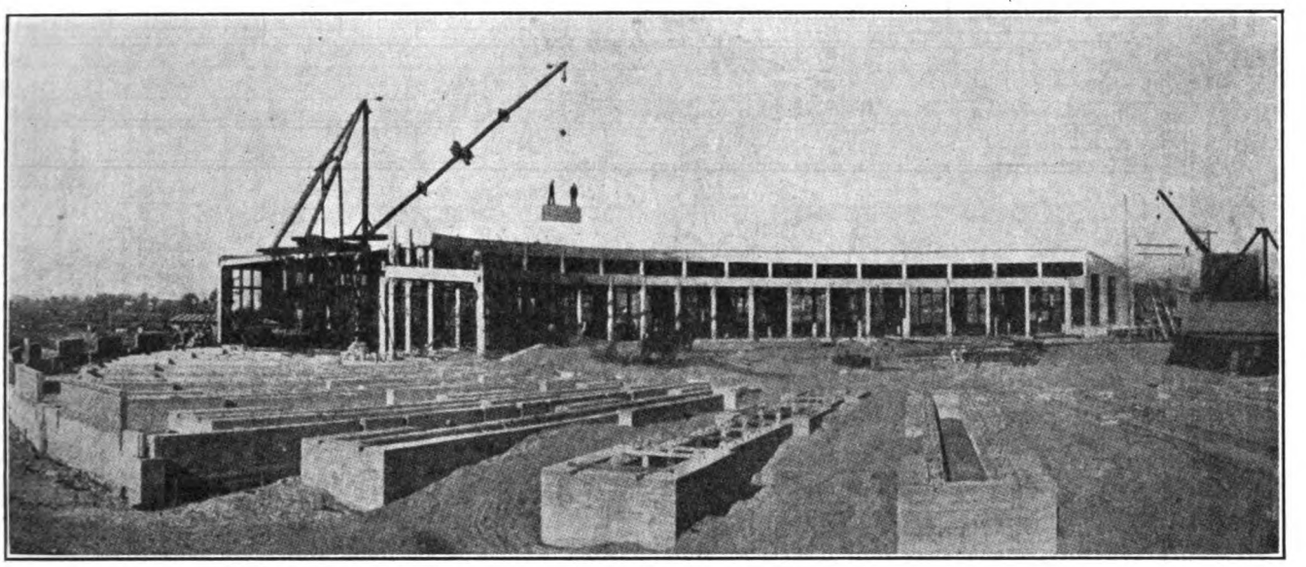

GENERAL VIEW OF REDONDO JUNCTION ROUNDHOUSE.

Concrete Roundhouse Constructed by the Unit Method

By SHIRLEY HOUGHTON*

Reinforced concrete is the best material for roundhouses on account of the fire risk in wooden and semi-fireproof structures. The unit method has been found useful in erecting such buildings, the first roundhouse to be constructed in this way being a 92-ft. 15-stall structure at Riverbank, California, for the Atchison, Topeka & Santa Fe Railway Co. This work was followed by the construction of a 25-stall reinforced concrete roundhouse for the same company at Redondo Junction, California, which was similar in general design to the Riverbank structure.

The Redondo Junction unit-constructed roundhouse has 25 stalls and 10 pits outside, giving 35 pits in all, besides one set of truck and drive-wheel pits. In addition, the terminal facilities at this point include a machine shop, wood-working shop, sand-house, car-repair shed, storehouse, power-house, roundhouse foreman's and engineer's supply-building, and a lavatory building.

The roundhouse has plain concrete foundations, and door-sills cast in place, with concrete window-sills resting on brick-work as shown. Reinforced concrete columns and girders support the reinforced concrete roof-slabs, and the walls are also reinforced concrete slabs with the exception of brick-work under the windows. The panels under the windows at the rear of the stalls were constructed of cement-plastered brick, instead of wood sheathing and metal-lath and plaster. It was found, in the event of a locomotive punching through this panel, that the repair of the brick panel was simpler, and that there was more salvage of materials than with the other style of panel. The doors and windows are of wood. The floor consists of vitrified brick set on edge in grout on a 3-in. concrete base. Drainage is provided by an 18-in. vitrified sewer pipe through the end of the engine-pits along the inner circle of the house, connecting with a concrete catch-basin with 9-in. walls. The interior is well-lighted not only because of the many windows, but also on account of the light color of the concrete. No doors are required in the roundhouse, as the climate is mild the year around.

*503 Market street, San Francisco.

Design

Loadings, Stresses, and Pressures. The roofs were designed for a live load of 40 lb. per sq. ft., as required by the Los Angeles building ordinance, and were tested by the city and by the railway company with a test load of 82 lb. per sq. ft. over an entire panel. The total load was 41,000 lb. and the total deflection over the span of 23 ft. 6 in. was $\frac{1}{8}$ in. All slabs and girders were figured as simple beams. The maximum loads are: on wall columns about 33,000 lb.; on interior columns about 53,000 lb.; and on columns for the inner circle about 17,000 lb. The maximum compression allowed for concrete was 500 lb. per sq. in., and the maximum tension for steel was 16,000 lb. per sq. in. The pressure under column footings was about 3500 lb. per sq. ft. The soil was firm sand and gravel and could support at least 5000 lb. per sq. ft. No tests were made on this point.

Foundation. The wall-slabs are carried on a continuous foundation-wall 10 in. thick, around the outer circle of the entire house. The columns are supported

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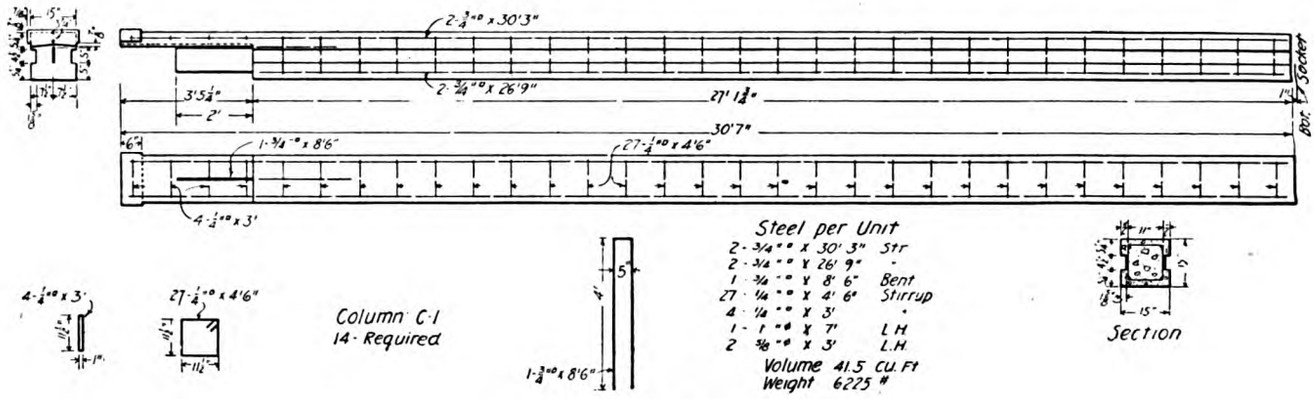

FIG. 1. DETAILS OF COLUMN C-1.

on square piers. Footings are founded on a deep bed of firm gravel.

Columns. Fig. 1 illustrates the method of keying the structure together. The two $4\frac{1}{2}$-in. vertical slots receive the keys in the wall-slabs, the whole being then grouted together. Corner columns have vertical keys and slots in adjacent instead of opposite faces, while interior columns are square.

The arrangement of reinforcement in column C-1 (Fig. 1) is typical. A $\frac{3}{4}$-in. vertical bar is placed in each corner, two of these being 30 ft. long, the other two being 26 ft. 9 in. long. The latter rods are in the side of the column, which is set back at the top, as shown, to receive and support the girder G-1 (Fig. 2). This offset in the top of the column requires a change in the stirrups. Below the seat for the girder there are twenty-seven $\frac{1}{4}$-in. square-bar stirrups, 4 ft. 6 in. long, spaced 4 ft. 6 in. centre to centre. In the thin section above the seat, the stirrups are rectangular as shown, four being used, spaced 3 in. centre to centre. Round bars are used as hooks and loops to provide a hold for handling units after casting.

Girders. Fig. 2 shows girder G-1, which is a combination exterior wall-girder and parapet. The cross-section shows the seat for the wall-slabs, and the elevation indicates the centre line of columns and the positions of columns and girders in the structure. The girder, which is eccentrically loaded because of supporting roof-slabs on one side only, is 6 in. wide at top, 3 ft. 5 in. deep, with a step or seat 8 in. thick projecting at the bottom $4\frac{1}{2}$ in. beyond the inner base, the span being 24 ft. 8 in. and the total length 25 ft. 7 in. The horizontal reinforcement consists of two straight $\frac{3}{8}$-in. square bars 27 ft. long in the top of the beam. Directly below these in the bottom there are two $\frac{7}{8}$-in. square 25 ft. 6-in. bars, one of which is bent up into top section at 4 ft. $3\frac{1}{2}$ in. from end, as shown in the illustration. A third straight bar, $\frac{3}{8}$-in. square and 25 ft. 3 in. long, is placed at the top of the roof-slab seat, with a $\frac{7}{8}$-in. square rod 25 ft. 6 in. long directly below it. The distance centre to centre of the double stirrups, fifteen $\frac{3}{8}$-in. square bars bent as shown in detail, ranges from 12 in. at support to 24 in. at centre. These stirrups are intended to serve a double purpose, to resist shear in the vertical beam, and to resist the tension and shear caused by the load carried by the roof-slab seat.

The girder G-l, (Fig. 2) 21 ft. 9 in. long, 12 in. wide and 28 in. deep, is designed also as a parapet, which explains its depth and shape and the ornamental cope at exterior bottom and top.

A typical girder is shown in G-2 (Fig. 3). The forms are simple as compared with the girder in Fig. 2. The roof-slab struts are carried on the $3\frac{1}{2}$-in. seats, the loads on opposite sides being approximately equal. The main reinforcement is designed for a beam 12 in. wide,

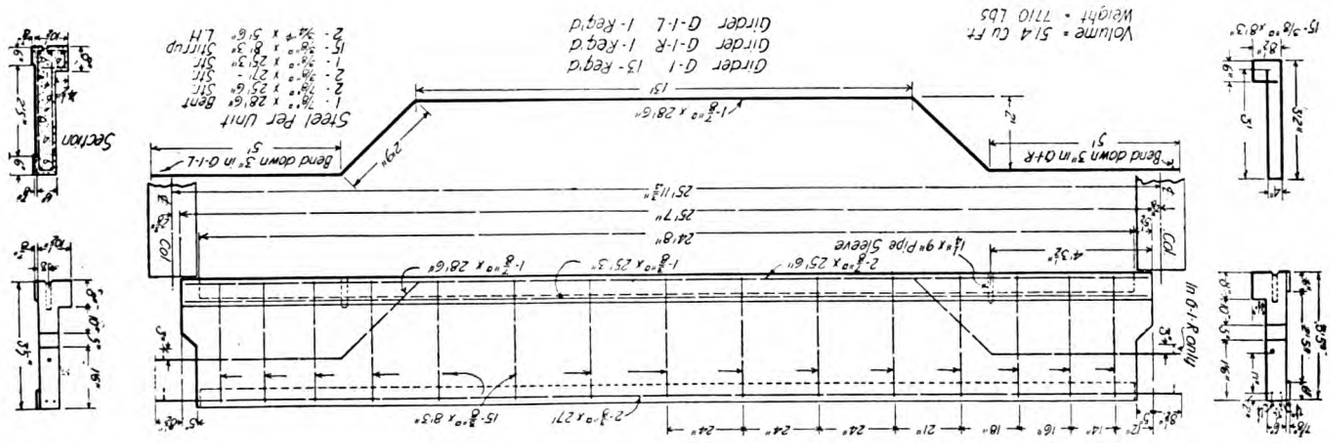

FIG. 2. DETAILS OF GIRDER G-1.

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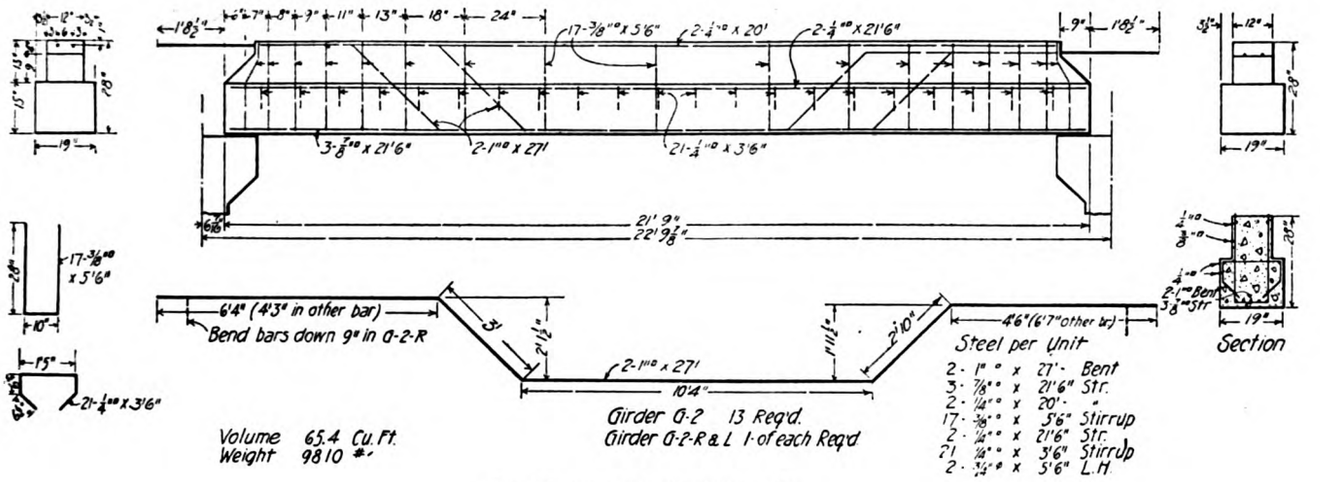


FIG. 3. DETAILS OF GIRDER G-2.

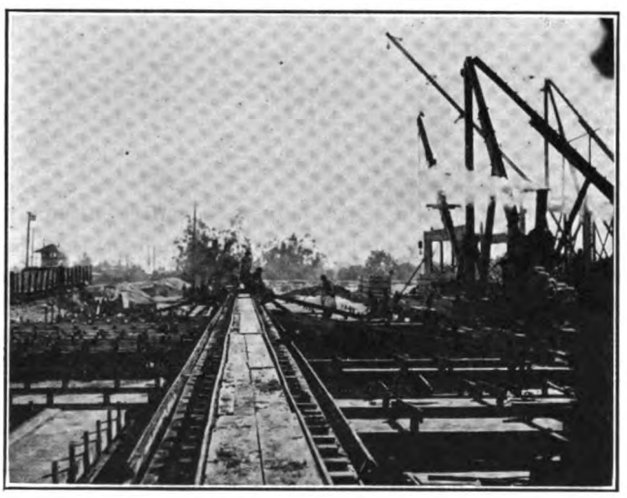
28 in. deep, and 21 ft. 9 in. long. The projecting seats are the supports for the roof slabs. The two 1-in. square bars 27 ft. long in the bottom are bent up into the top of beam as shown in the elevation. The three $\frac{7}{8}$-in. square bars 21 ft. 6 in. long in the bottom are straight bars. The top of the beam is reinforced by two $\frac{1}{4}$-in. square bars, straight, 20 ft. long, while the seats each have near the corner, one longitudinal $\frac{1}{4}$-in. square straight bar 21 ft. 6 in. long. The twenty-one $\frac{1}{4}$-in. square stirrups 3 ft. 6 in. long are bent as shown in the detail drawing and are designed to care also for the stress in the lower portion of the beam due to roof-slab loads on the seats. The bent portion at the end of the bars gives increased resistance to the tension developed. The spacing of these short stirrups is indicated in the lower part of the elevation of girder. The seventeen $\frac{3}{8}$-in. square stirrups 5 ft. 6 in. long are bent as shown. The distance centre to centre varies from 6 in. at the supports to 2 ft. $10\frac{1}{2}$ in. at the centre.

Roof-Slabs. A typical roof plan is shown in Fig. 4, illustrating the construction and method of assembling and order of placing the slabs and girders. The girders are erected in the order indicated, G-1, G-2, G-3, G-4, G-5, and G-6, the girders at the inner circle having been completed previously.

Slabs S-1, S-2, and S-3, shown in Fig. 5, have the same width and thickness, but the lengths are respectively 22 ft. $7\frac{1}{2}$ in., 22 ft. $4\frac{1}{2}$ in., and 21 ft. $1\frac{1}{2}$ in. In the section of roof shown, which covers three stalls, there are 12 different sizes of slabs, each with a thickness of 3 in., the total number of roof slabs in this section being 46. Over a single stall there are 16 slabs and 12 different sizes. The use of several duplicate slabs in each section reduced the work of design as well as the necessary number of different sized forms. This reduction makes the assembling and construction easier and less expensive.

The arrangement of the roof slabs is especially economical and shows the adaptation of this type of structure to circular buildings. The method of assembling is simple and easy to understand, especially when compared with other types of buildings, such as a steel-frame structure.

The arrangement of girders is shown in the part-roof plan. The spans between girders are taken care of by struts 15 in. deep cast integral with the slabs. This is shown in the sections taken through slab S-1. The reinforcement in the bottom of the longitudinal strut, 15 in. deep, in slab S-1, which is typical, consists of the following: one $\frac{3}{4}$-in. square straight bar in the bottom of each girder section, one $\frac{5}{8}$-in. square rod bent up into the top of the slab with a 2 ft. 2 in. bend at the point shown; the latter bars project 11 in. beyond end of slab and are bent over and tie to bars cast into



VIEW OF CASTING-YARD.

the girder G-1. At the opposite end, which is an interior joint in the structure at G-2, the projection is 1 ft. 5 in. In the top of strut, in each corner, there are $\frac{1}{4}$-in. square longitudinal straight bare, one 23 ft. 6 in. long, the other 22 ft. 6 in. long. Each transverse-slab strut, 15 in. deep, is reinforced by two $\frac{3}{8}$-in. bars 10 ft. long, one in top and one in bottom, bent as shown in the detail. In the slab proper, 3 in. thick, the transverse reinforcement consists of nineteen $\frac{1}{4}$-in. round rods 5

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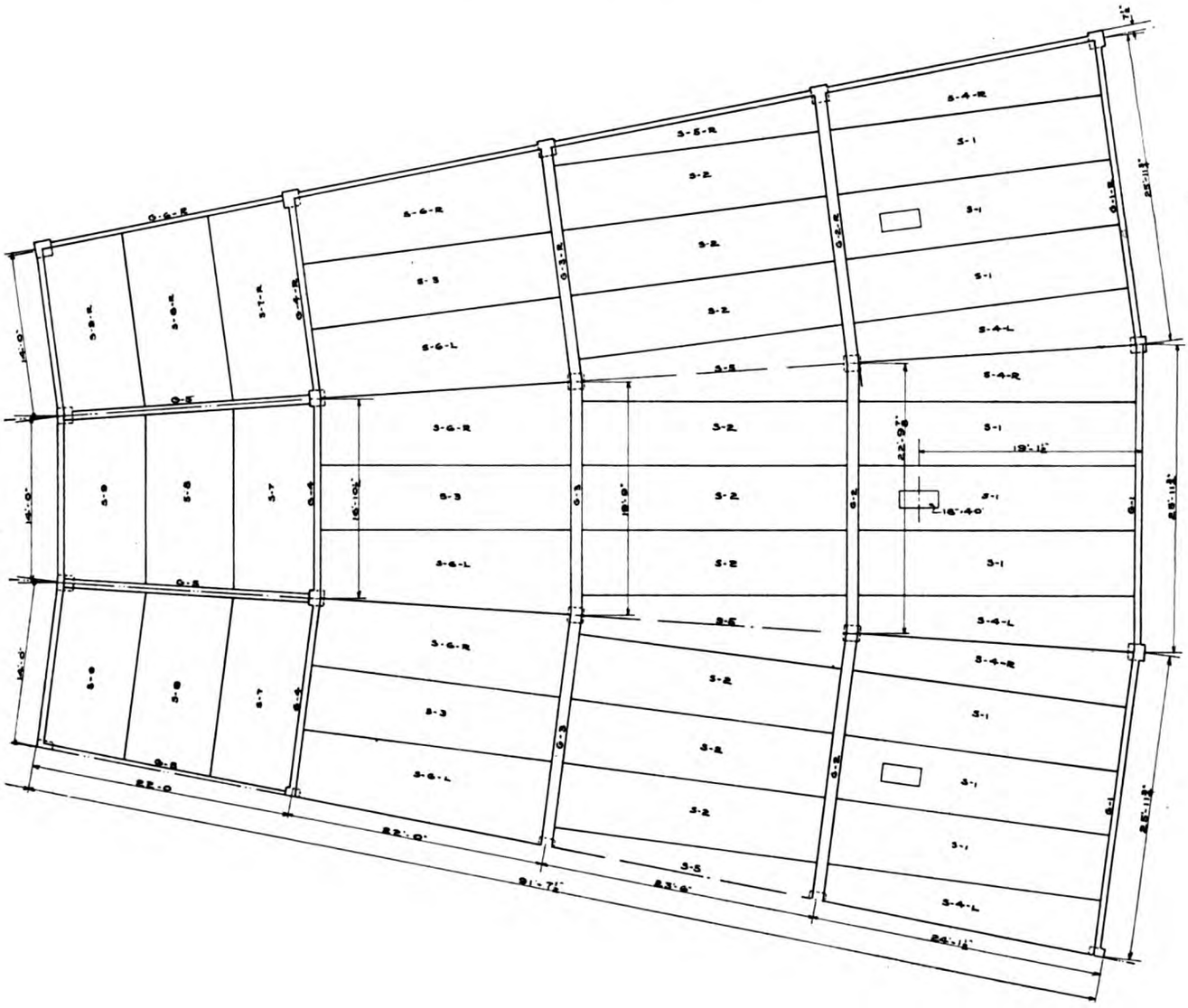

FIG. 4. ROOF PLAN.

ft. 3 in. long spaced 13 in. centre to centre, alternated with twenty ¼-in. round rods 10 ft. long bent similarly to those in the end struts, these also being spaced 13 in. centre to centre, making the net spacing 6½ in. centre to centre. The longitudinal reinforcement consists of four ¼-in. square rods, two at extreme edges, and two placed 1 ft. from the bars at the extremities. The number of bent bars used, and the bending details

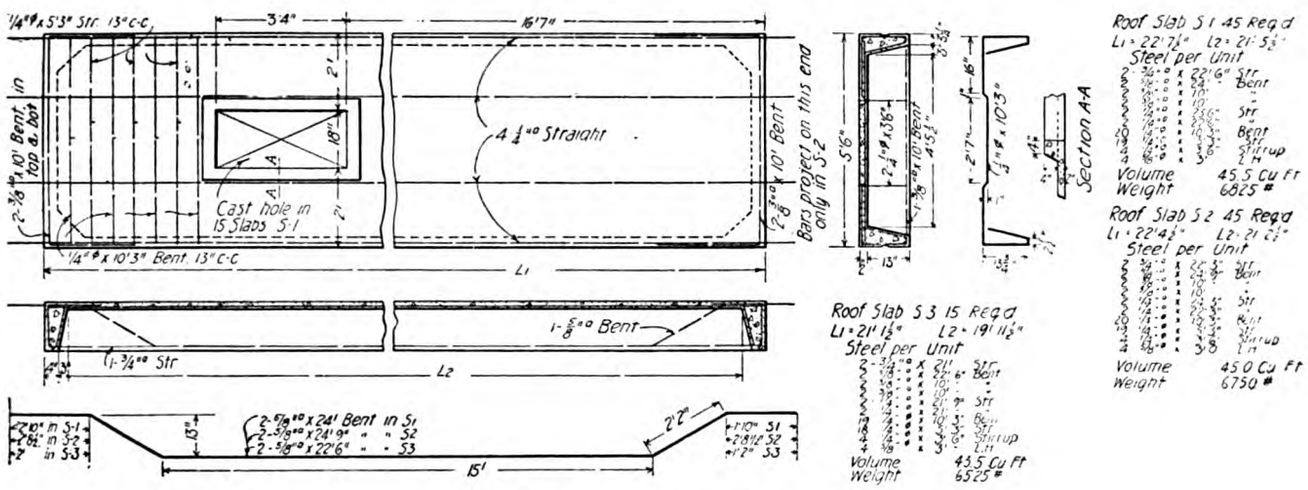

FIG. 5. DETAILS OF SLABS.

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insure that the slabs are tied together so that the full bonding strength is developed, which is essential with these 3-in. slabs. The arrangement of the bends in the bars is such that the stress is in every case in the opposite direction from the thinnest concrete covering, and the tension developed cannot break out a small strip of concrete and expose the bar.

The design of the other slabs is similar to that of S-1, the slabs being 3 in. thick with 15-in. struts. Some of the slabs, however, had to be designed wedge-shaped, thus requiring a somewhat greater variety in the lengths of the transverse bars. The spacing is also different, being 9 in. net in the slabs S-4-R and S-4-L.

Roof Waterproofing. Roof waterproofing consists of four thicknesses of tarred felt weighing 14 lb. per 100-ft. square, 120 lb. straight-run coal tar roofing-pitch and 300 to 900 lb. screened gravel to the square.

Work was started at the gutter or eaves by laying one thickness 32 in. wide. The second layer was folded double, making the second strip 16 in. wide, and mopped with hot pitch. Then a third layer was applied full width, making four thicknesses. Then starting at a point back 16 in., which was the end of the four-thickness portion, a sheet was laid 7½ in. each time, mopped on the sheet underneath, and the operation repeated, dropping back 7½ in. each time and mopping the full width of the lap. A 3-in. portion was turned up at the end walls, mopped and cemented together, and nailed down with lath. The entire surface was mopped hot and graveled.

Walls. Wall slabs, W-1-R and W-1-L are vertical wall slabs which butt against column C-1, as shown in the rear elevation. These two slabs, with the brickwork and column C-1, make up the standard rear walls for each stall, up to the top of the windows.

The slab W-1-R, (Fig. 6) 8 in. thick, 4 ft. 3¾ in wide, and 22 ft. 7½ in. high, has a vertical post 6 by 10 in. at the left to form reveals, and window-casings. The 8-in. slab is reinforced vertically by four ¼-in. square bars 22 ft. long, two placed near the right end of slab, one near each base, the other two being similarly placed near the centre of the slab. The end-post has four ⅝-in. vertical bars, one in each corner as shown. Two ⅝-in. square stubs 2 ft. long are placed one at the top and one at the bottom of the post, projecting 4 in. to provide bond when erected.

Horizontal reinforcement in the end-post consists of 15 ¼-in. stirrups, 2 ft. 6 in. long, spaced 18-in. centre to centre. The slab is reinforced horizontally near each face with fourteen ¼-in. square rods 4 ft. long, spaced 18-in. centre to centre. The volume of the slab is 37 cu. ft., the weight being 5550 lb. The design of the other slabs is somewhat similar, the details of the reinforcement being changed slightly, but following the method indicated on W-1-R.

Connections. The method of bonding the units together is shown in the details. The protruding bars of two opposing girders and a corresponding bar protruding through each side of the column are securely clipped together by cable clips, to provide a mechanical bond in addition to the bond of the concrete. Between the roof-slabs, the bond is provided by grouting between the slabs, each of which has a key about 1 by 3 in. in the side. Over the girders, bond is provided by clamps applied on the ends of protruding bars similar to the design of the beams at the columns.

Materials

Mixture. The foundations were 1:3:5 concrete, using clean sharp river sand and clean broken stone

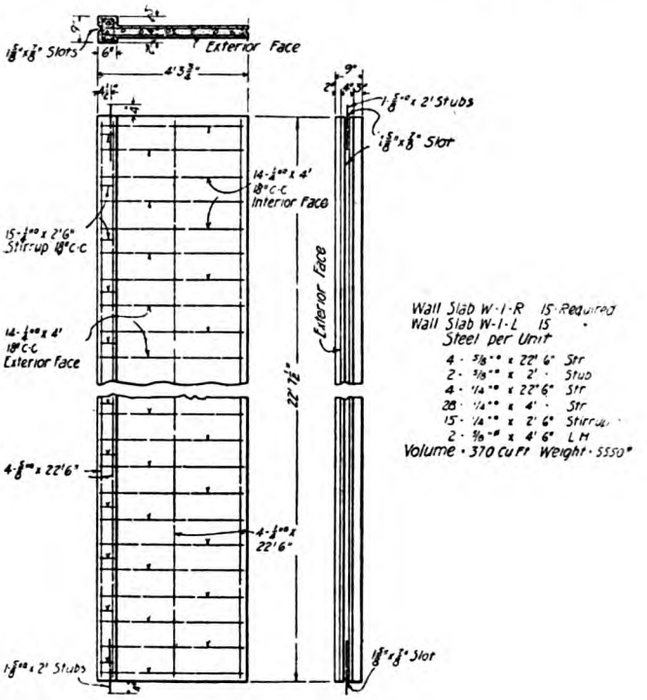

FIG. 6. DETAILS OF WALL SLAB.

passing a 2-in. ring. The concrete was made fairly dry, was well tamped, and was spaded next to the forms, the specifications requiring a good surface without honeycombing.

Reinforced concrete was made with a 1:2:4 mixture using stone passing a 1-in. screen. Stone passing through a ⅛-in. mesh was accepted as sand, if clean. Reinforced concrete was made wet enough to flow freely into the crevices and around the bars.

Reinforcement. Deformed bars meeting the requirements of the specifications of the Association of American Steel Manufacturers were used, and bars were required to be clean of dirt, dust, oil, grease, or anything which would destroy or weaken the adhesion.

Forms. Forms were made of select Oregon pine, and were designed to carry the full weight of the concrete as a liquid without deflection or bulging.

Roof slabs S-1, S-2, and S-3 had the same width and were all cast in forms built for slab S-1, which was 22 ft. 7½ in., while S-2 was 22 ft. 4½ in., and S-3 was 21 ft. 1½ in. long. The only adjustment necessary was to move

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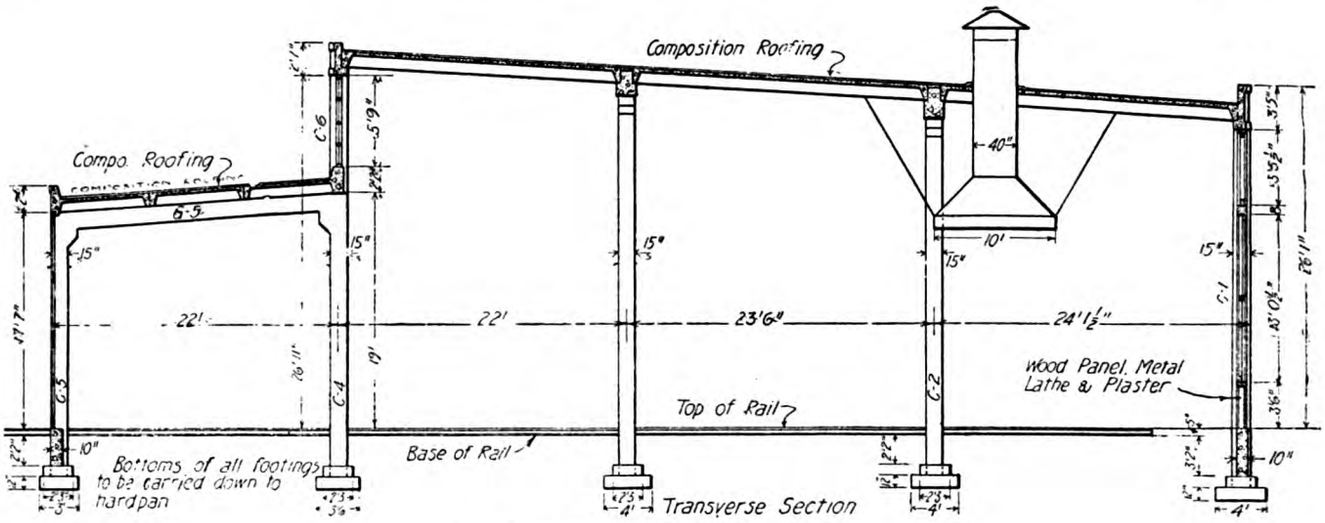

FIG. 7. SECTION THROUGH ROUNDHOUSE.

the end-wall of the form 3 in. when pouring slabs S-2, and to move the end-wall a further distance of 1 ft. 3 in. when pouring S-3.

Construction

Concrete Plant. The units were cast in a yard adjacent to the roundhouse. The concrete plant was a stationary one, consisting of a mixer and engine mounted on a pile-trestle. Sand and stone were unloaded directly on the ground from railway cars, and cement was stored in a small building on the trestle. The stone and sand were delivered by hand in proper proportions in wheelbarrows to a hopper on the ground, which was then pulled up an inclined track and dumped into the mixer.

A narrow-gauge track was mounted on a light trestle. Concrete was delivered by narrow-gauge dump-cars with steel bodies to inclined chutes which led down to the forms. The incline of the chutes was not sufficient to carry concrete to forms, and it was shoved and pulled down the chutes with spades and hoes. The forms were mounted securely on heavy timbers which were leveled and founded firmly to prevent settlement. The narrow-gauge cars were propelled by hand. The members were taken from the yard to the site of the building by locomotive cranes, the crane removing the units from the forms and placing them on flat-cars for delivery to the erection derrick.

From four to six boxes were made for each unit, which would mean that about nine to six units were cast per box. Herein lies one great advantage of unit construction: the consecutive use of these boxes is possible without taking the lumber apart and building it up again. In building a monolithic building, the form lumber is used a number of times, but every time it is used it becomes rougher on account of renailing and splitting, consequently giving a non-uniform and progressively poorer surface-finish.

Erection. The erection was done by traveling stiff-legged derricks, moving on rails laid on timber stringers laid across the tops of the pit-walls. Two derricks were used, working away from each other, starting near the middle of the roundhouse. The second derrick was not started until after the first one had progressed far enough to prevent any interference. In the photograph produced, one derrick is just completing an end of the house, while the other has seven stalls to erect. Note that swinging hook is mounted on the derrick tower at a point above the level of high part of roof. The structure never interfered with the boom, even after fully erected.

Hooks or loops were cast in each unit to facilitate handling by the crane and derricks. These loops were

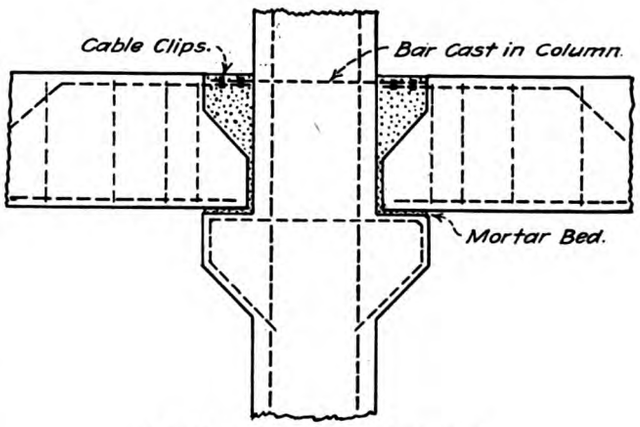

FIG. 8. DETAILS OF CONNECTIONS.

short, round rods, as indicated in the tables of bars shown on the various diagrams.

Truck and Drive-Wheel Drop-Pits. Truck and drive-wheel drop-pits were installed in accordance with plans for same, together with sheet steel covers.

Smoke-Jacks. Smoke-jacks were of transite asbestos and suspended from the concrete roof slabs, as shown in the section of the house and in the photographs.

Surface Finish. The forms were made of select Oregon pine. The exterior surfaces were cast upward and floated. The forms were surfaced and oiled before pouring, and the concrete was carefully tamped and

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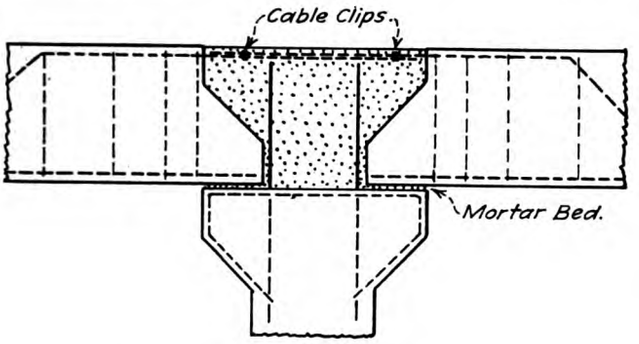
spaded. No other finish was given, a smooth surface being obtained in the original casting. The specifications required all rough places to be smoothed off, and especially required that the roof-slabs should be smooth for receiving the composition roofing.

Costs. In general, the average cost of temporary forms for structural concrete is from one-quarter to one-third of the total cost of the structure. This is due to the constantly increasing price of lumber, and the unsatisfactory results obtained with standard steel forms for monolithic construction. The cost for the unit-type roundhouse is somewhere between a concrete-wall and wood-roof building and a monolithic concrete building. The type described in this article costs from $2500 to $2600 per stall. This is about $0.06 per cu. ft. or $1.40 per sq. ft., including engine-pits.

The roundhouse of the San Pedro, Los Angeles & Salt Lake railroad at Lynndyl, Utah, containing ten



Girder and Column Connections.

FIG. 9. DETAILS OF CONNECTIONS.

stalls, was similar in design and construction to those at Riverbank and Redondo Junction, although the dimensions were somewhat different. An interesting feature in connection with the construction of this roundhouse was the construction of the whole building in winter weather. This was possible because all of the units for the structure were cast before the extreme cold weather set in, leaving only the erection work to be carried on during the extreme weather conditions. This program was carried out, and the work of making connections and concreting them, after erection, was handled on such days as the weather was propitious for such work. This procedure resulted in the building being completed and turned over to the railway company several months before it would have been possible to do so with any other form of construction than the unit method.

The Riverbank roundhouse was designed and constructed under the supervision of H. F. Phillips and G. W. Harris, chief engineers for the Atchison, Topeka & Santa Fe coast lines. The Redondo Junction roundhouse was designed and constructed under the supervision of G. W. Harris, chief engineer for the Atchison, Topeka & Santa Fe coast lines. The Lynndyl roundhouse was designed and constructed under the supervision of R. L. Brown, engineer of maintenance of way for the San Pedro, Los Angeles and Salt Lake railroad. The designs were made and the work of construction carried out in each instance by Van Sant-Houghton Co., Western representatives of the Unit Construction Co., of St. Louis, Missouri, the latter company controlling unit construction through a number of patents.

METHOD OF LEVEE AND BANK PROTECTION

The report of the Board of Engineers on flood-control in Los Angeles county contains an individual report by H. Hawgood, discussing methods of levee protection. Where boulders are available, the best protection is a facing of hand-laid boulders, with a mound of loose boulders deposited along the toe of the levee to sink into and fill any cavities made by erosion.

Where boulders are not available, a concrete-slab protection, 4 in. thick, ribbed on the under side to check slipping, over the upper half of the levee slope, with an articulated concrete mat placed over the lower half, and extending as an apron on the bed of the channel. The solid slab is used on the upper part of the slope to reduce construction cost and because flexibility is not essential in that portion. Where the levee contains sand, this reduction of the number of joints minimizes the risk of the sand being washed out through the joints. To prevent washing through the joints when the levee is constructed of fine sand, a blanket of coarse material should be spread over the face of the levee, or else it may be consolidated by sprinkling with asphaltic oil. Whenever practicable, the first method should be used, as it forms a better base for the concrete slabs.

For protection of the banks of small channels, a mat may be made by laying wire netting on the levee slope, extending several feet into the bed of the channel, and covering the netting with cobbles and small boulders, then laying more netting on top and wiring the two nets together. This method has been successfully employed for a torrential stream near Burbank, California.

Stones wrapped in galvanized netting formed into rolls about five feet in diameter has been used in streams in India. The netting may be expected to last about fifteen years in most parts of the West before it fails on account of rust.

Covering both the levee and part of the adjacent channel-bed with a mixture of sand and gravel and asphaltic oil has been tried in several places with varying success. A bank at the Silver Lake reservoir, Los Angeles water supply, is a successful instance, while the Southern Pacific banks along the Salton Sea were an unsuccessful instance. It is possible that the use of an asphaltic concrete layer over the levee would be more effective than the above and would at the same time be less expensive than cement-concrete protection.

Brush fascines and mats should be employed as temporary protection only. Where the ground is sufficiently moist throughout the year to support plant-life, willows and bamboo may be planted.

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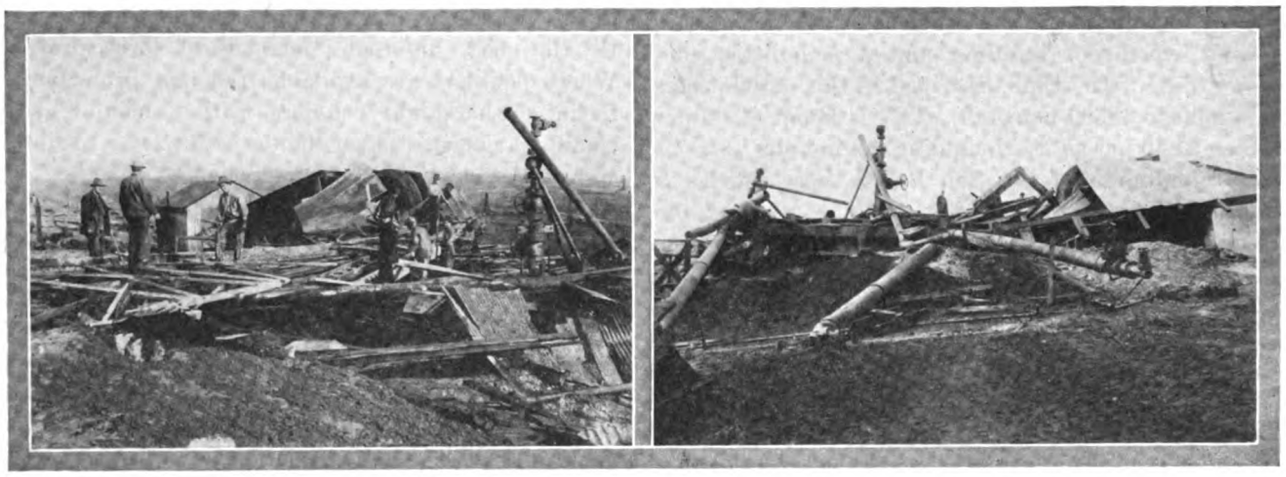
Storm-Wrecked Derrick in Midway Oilfield

The accompanying photographs were contributed by Paul M. Paine, superintendent for the Honolulu Consolidated Oil Co. at Taft, California, and show two views of what was left of the derrick over one of the Company's gas wells in that district after the storm of January 27. While the derrick itself was wrecked completely, the high-pressure fittings were fortunately undamaged, and turning a valve was all that was necessary to prevent loss of the gas. Except for this fact, controlling the flow would have been difficult.



Proposed State Highway Laterals for Northern California Counties

The accompanying map shows the arrangement proposed by A. B. Fletcher, state highway engineer of California, for laterals connecting the county-seats of the mountain counties in northern California with the trunk-lines of the State highway. The main routes through the Sacramento valley and northerly to the Oregon boundary are shown by heavy full lines. The lighter full lines show the routes proposed by the State Highway Commission for the mountain laterals. Alternative routes for these laterals are shown by dotted lines.

The Weaverville lateral has been definitely decided. It will run from Redding and the total length will be 50 miles, 18 of which has been surveyed. The Pit River route for the Alturas lateral has been practically abandoned. It would cost $350,000 to $400,000 more than the route *via* Hatchet Creek mountain recommended by the Commission. The interest on this amount would be several times the cost of keeping the Hatchet Creek Mountain route open during the winter. An alternative route is proposed *via* Susanville. This would require less road-building and would be somewhat less expensive, but it is believed that it would not serve the needs of the people of Modoc county as well as the road to Redding.

A large part of the lateral to Auburn is under construction and the route from there to Nevada City has been virtually decided. The commission favors a highway from Downieville to Quincy and from there to Susanville, a total distance of 110 miles, as against one from Oroville to Quincy, 65 miles, and from Redding to Susanville, 100 miles. This is mainly on account of the decreased mileage to be built and consequently reduced expense. It is well known that a road from Oroville to Quincy *via* the North Fork of the Feather river would be expensive. The Downieville-Quincy route is opposed by most of the residents of the region, who state that automobile traffic would be impossible for a large part of the year on account of snow. Another route suggested for the Downieville lateral is from Marysville *via* the Yuba river. Other routes that have been suggested for the Oroville-Quincy lateral are the improvement of the present road *via* Meadow Valley and the construction of a road along the Middle Fork of the Feather river for part of the distance and then following ridges to avoid Bald Rock canyon.

The members of the State Highway Commission have stated that the proposed routes are still tentative and that they will do their best to satisfy the needs of the residents of the mountain counties with the money available. Construction of practically all the laterals under discussion is dependent upon the passage of the additional bond issue of $15,000,000 to be voted upon in November.

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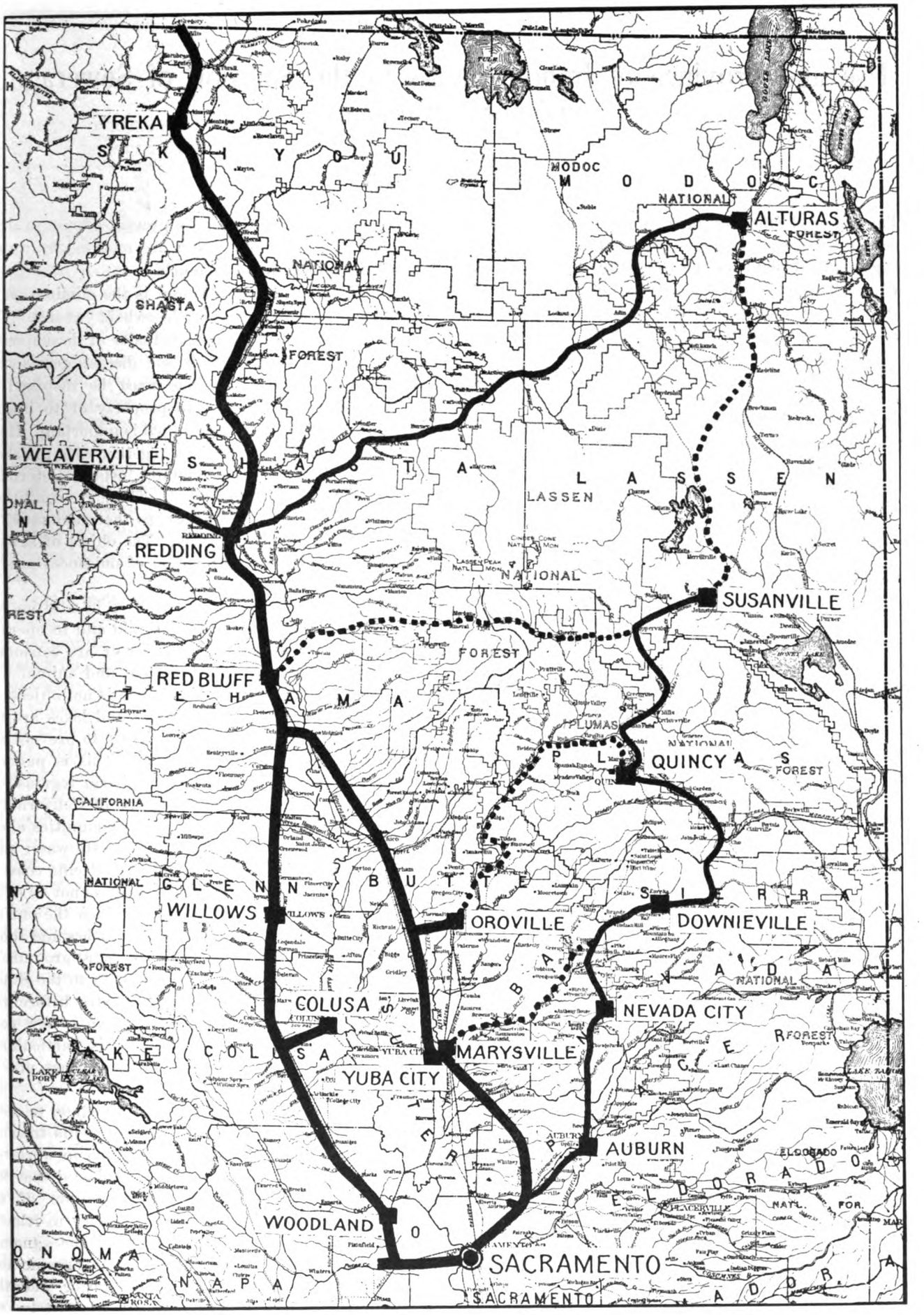

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Use and Province of Imhoff Tanks in the Solution of Sewerage Disposal Problems

By F. V. HAMMERLY*

The use of clarification tanks of the Imhoff two-story type is playing such an important part in the design of sewage-disposal plants of the United States that the following article may prove of interest and value to engineers and superintendents of sewage-disposal plants on the Pacific Coast. It is based mainly on observation of the conditions encountered and the practice in general use in California at the present time.

Until recently the treatment of sewage-disposal problems in California has been limited usually to the use of septic tanks, whose function is the clarification of raw sewage as well as to attempt to handle the resultant deposits. As outlined later, this function of the single-story septic tanks has been a failure because of the fact that the two processes took place in the same tank and interfered with each other. The main feature of the Imhoff tank is the separation of the two processes.

Until the appearance of the Imhoff tank, even the best plants for final treatment of sewage were far from satisfactory in their operation and results. The Imhoff tank has also helped to solve the perplexing problem of sludge disposal, since it produces a thoroughly digested and odorless sludge. It is a modification of the two-story Hampton or Travis tank, which was built by Travis and his associates at Hampton, England, and put in service in 1903.

Before reviewing the design and operation of the Imhoff tank, it is advisable to discuss briefly the problem of sewage disposal and the natural process of septicization of organic matter, together with the function and limitation of the Imhoff tank.

Sewage is the spent water of a community, the household and human wastes, and may or may not include street washings and industrial wastes. The natural process of disintegration usually begins before it enters the collecting systems. It is not only offensive to both sight and smell, but also contains millions of bacteria. Most of these are harmless, but the bacilli of the water-borne diseases may be present. These are so named since sewage-polluted water supplies serve as a vehicle for their transmission. The most common are typhoid fever, Asiatic cholera, and diarrhoea, or amoebic dysentery.

Water-borne diseases are intestinal diseases and the bacilli leave the human body through the feces or urine with the harmless bacteria, which compose from 20 to 35% of the excreta. The fecal matter commences to break up in the collecting sewers and becomes partly dissolved in the sewage water, leaving it polluted and heavily laden with bacteria. To prevent offense to sight and smell, the household wastes are removed by water-carriage in underground channels.

The problem of sewage disposal is the elimination of all objectionable features of household wastes. The first of these is the appearance and odor of decomposing organic matter. The other is the disease germs contained in the sewage. Sewage must be disposed so that no injury will be done to property or to health. The economic side of sewage disposal is important. However, the geographical conditions, together with the character of the sewage of a community, usually determine the type of sewage-disposal plant. These are conditions that cannot be altered materially, so the plant must be designed with reference to them. The object of sewage disposal is the effective elimination of nuisances arising from sewage at minimum expense.

Ordinarily the works that are required by dilution are the simplest and cheapest, both to build and to operate. When the wastes dispersed in the water are consumed by bacteria and larger forms of plant and animal life, so that no nuisance results, this method is not objectionable. But in many cases the streams and lakes are far too small to dilute the sewage sufficiently to prevent the transmission of water-borne diseases. This is particularly true in California and other semi-arid regions. It has been proved that the largest stream of California is too small to dilute the sewage of the communities along its shores sufficiently to preserve it as a safe water supply. In some of the larger cities on the Pacific coast it has been found that dilution in the ocean is not as effective as could be desired. Solid wastes from the outfall sewers are deposited frequently on the beaches and shore by the tide. As the beaches are the pleasure grounds of so many pople, and are a source of wealth to the State, the separation of the solid organic wastes before the sewage water is allowed to enter the ocean is now considered a minimum requirement. This is particularly true in southern California, where the beaches are in such general use as pleasure-grounds.

Because of the failure of the dilution method to meet the conditions of sewage disposal requirements in most cases in California, sewage must be treated in works of artificial construction. It must be remembered that the scope of sewage disposal is the elimination of all nuisance. To accomplish this, it is necessary to remove from the raw sewage the objectionable substances; namely, the floating matter, settling solids, both organic and inorganic, the non-settling putrescible matter, and the objectionable bacteria. To eliminate completely all

*753 Monadnock Bdg., San Francisco.

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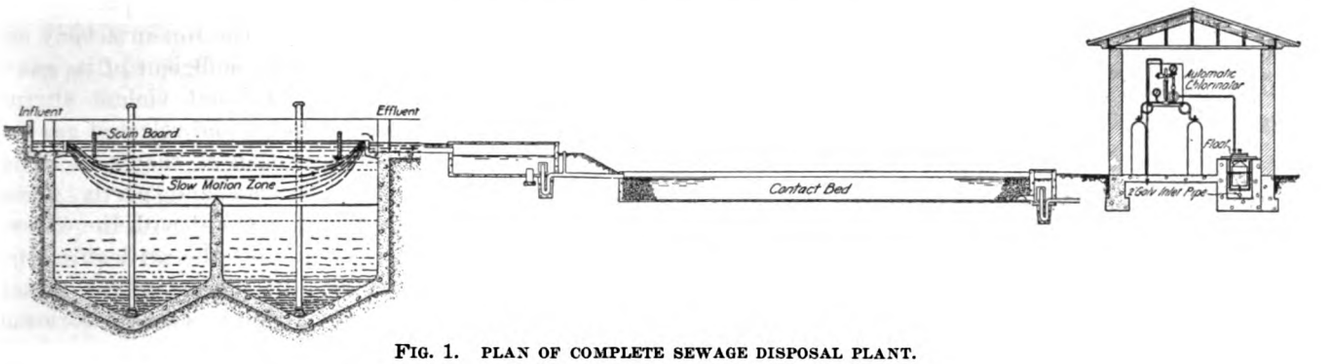

FIG. 1. PLAN OF COMPLETE SEWAGE DISPOSAL PLANT.

nuisance, a sewage-disposal plant must be built and operated at several distinct units, each unit performing a separate and distinct operation. At present, there is no single effective method that combines these several distinct operations.

Fig. 1 shows an outline plan for a complete sewage-disposal plant. The Imhoff tank collects the floating material, and removes and disposes of the settling solids. The effluent then passes through contact-beds, where the non-settling putrescible matter is removed and oxidized. It is then treated with chlorine gas which destroys the dangerous bacteria. This is a complete sewage-disposal plant.

It should be borne in mind that the conditions affecting sewage disposal are usually quite different in different communities. Each has a separate problem that demands its own solution. In some communities it may be necessary to remove only the solid material which gives offense to the sight and smell, and the sewage relieved from these objectionable wastes may then be removed without further treatment. In many cases it is necessary to treat the effluent further, either by chlorination, dilution, or filtration, or by broad irrigation. Sometimes a combination of treatments is necessary to remove all the danger of polluting a domestic-water system. In California broad irrigation is favored to dispose of clarified sewage, particularly where water has an unusually high value.

Septicization. Imhoff tanks employ the natural process of decomposition of organic matter to reduce and dispose of the settling solids. The decomposition of organic matter is accomplished by infinitely small organisms or bacteria. These sewage-digesting bacteria include many species, most of which are harmless. Some bacteria require free oxygen in order to live. These belong to the class known as obligatory aerobes. Others do not grow or thrive unless free oxygen is practically absent, and are known as obligatory anaerobes. Still others can live either in the presence or absence of oxygen and are classed as facultative anaerobes. When sewage is fresh it contains free oxygen and the aerobic bacteria predominate. The decomposition products formed by these have no offensive odors. In stale sewage, or sewage without free oxygen, anaerobic bacteria predominate. The decomposition products formed by many of these organisms are offensive, and some form hydrogen sulphide gas (H_2S), the characteristic odor of decomposing organic matter. When fresh sewage is stored, the aerobes in their life process consume the free oxygen, generating conditions favorable for the anaerobes. The entire process of decomposition is not accomplished directly by the living bacteria, but mainly by soluble ferments, called enzymes, that are diffused by the cells.

The Septic Tank. Anaerobic action is one of the most effective processes of organic decomposition; it brings about the partial liquefaction or gasification of the solids. A septic tank is simply an improved cesspool in which anaerobic action for the disintegration of organic wastes is utilized. The septic-tank process is a preliminary treatment to remove and dispose of the settling solids from raw sewage. This is the function and limitation of the Imhoff tank, and is all that any settling-tank in itself can accomplish. No clarification tank removes the bacteria in any greater proportion than it does the solid wastes. The bacilli of the water-borne diseases are not destroyed in such tanks. The septic-tank process has been so consistently exaggerated that to the average man the term 'septic tank' means a complete process of sewage disposal, and to others who have had experience, the synonym of failure of sewage disposal.

As stated before, there are two distinct parts to the septic-tank process. First, the clarification of the raw sewage, or the sedimentation of the settling organic solids; second the digestion of this deposited matter to facilitate its disposal. The usefulness of sedimentation has been found chiefly as an aid to filtration. It prepares raw sewage most effectively for such after treatment as may be employed to eliminate the baccili of the water-borne diseases, and to remove the non-settling putrescible matter, most of which is either so finely divided that it will not settle by gravity or else is in solution.

In the ordinary septic tank, both processes, digestion and sedimentation occur in the same chamber. The Imhoff tank is so constructed that it separates these two phases of the process. The deposition of settling solids is completed in the settling-chamber before the sewage becomes stale, consequently the settling-chamber is operated on a aerobic basis. The effluent, or clarified sewage passes from the settling-chamber in a fresh con-

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dition. It contains free oxygen and therefore has no foul odor. The sludge in the lower or sludge-digestion chamber, however, contains no oxygen, so it operates on an anaerobic basis. Since there is no direct connection between the two tanks, neither operation interferes with the other. Thus the Imhoff tank makes use of anaerobic decomposition of the sludge and yet delivers a fresh effluent, being in this respect superior to the one-story tank.

All septic tanks must provide for the sedimentation and decomposition of the sludge. Since digestion of the solids interferes with sedimentation in one-story septic tanks, the sewage must be stored from eight to thirty hours to insure sufficient sedimentation. These tanks employ only anaerobic action. The sewage waters become saturated with offensive decomposition-products, and the effluent of such tanks has the characteristic odor of stale sewage. It also contains so much partly decomposed organic matter in suspension that it clogs sprinklers and filters, thus rendering them useless in after-treatment works. Where one-story septic tanks are employed they remove only from 40 to 75% of the settleable organic solids, leaving the effluent foul. The following description by Leslie C. Frank of the process of decomposition in the sludge chamber shows the conditions under which sedimentation is attempted in one-story tanks. "The treatment of sludge, generally conceded to be the most difficult part of sewage disposal, differentiates Imhoff tanks from other sludge-disposal plants. They are constructed so that the fresh sludge that enters the sludge-digestion chamber cannot re-enter the settling-chamber. There is normally a quantity of sludge lying at the bottom, generating gas within its 'live' particles, and continually emerging from this lower sludge body and rising and falling in the liquid above it are other particles of sludge which have generated sufficient gas to give them the required buoyancy, and which are either in the act of rising to give up this gas or have given it up and are again settling. At irregular intervals part of the mass of the sludge may rise to the top in a body and remain there till it has given up sufficient of its gas to settle again." It is this continual violent stirring action of the decomposing sludge and released gas that interferes with the sedimentation of the fresh sludge in one-story tanks. The floating and partly decomposed sludge is frequently carried out with the effluent. This causes the low extraction of the settleable solids of one-story septic tanks. In these tanks a mat or scum of partly decomposed sludge usually forms on the surface of the stored sewage. The anaerobic decomposition in this mat becomes retarded as its upper side dries. In a mild climate, such as that of most of the Pacific Coast, it has been proved that this scum is of no aid to the process. In colder climates, by retaining part of the heat of decomposition, it probably does aid the septic action in cases of open one-story septic tanks, but for closed tanks it is useless. It should be noted also that the scum on open one-story septic tanks may serve as an excellent place for breeding flies.

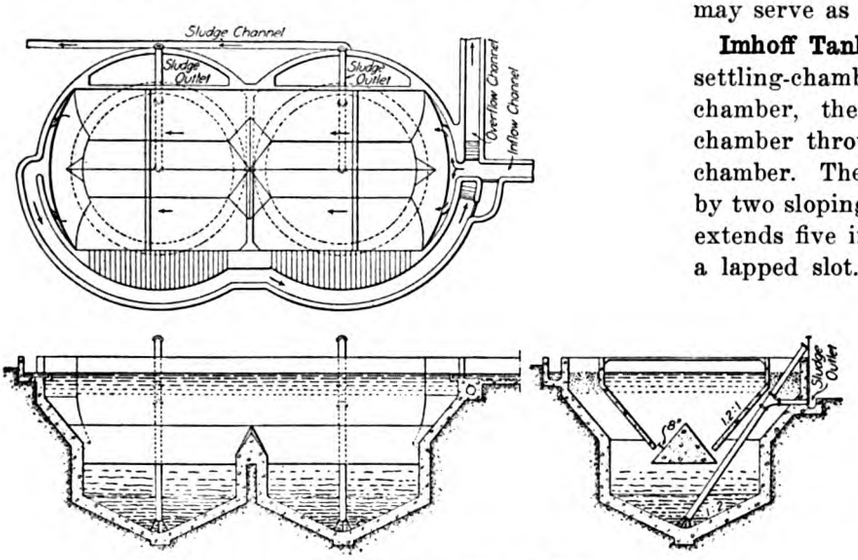

FIG. 2. SKETCH OF IMHOFF TANK.

Imhoff Tank. The Imhoff tank proper consists of a settling-chamber suspended over a sludge-digestion chamber, the sludge entering the sludge-digestion chamber through slots in the bottom of the settling-chamber. The bottom of the settling-chamber is formed by two sloping sides. These sides do not meet, but one extends five inches or more beyond the other to form a lapped slot. Solids settling in the settling-chamber are deflected by the sloping sides through this slot into the sludge-digestion chamber. Decomposing sludge particles rising in the lower or digestion-chamber when generating gas, move in a vertical path. Therefore they are deflected to one side by the lapped slot and cannot pass back into the settling-chamber. There are three different designs of sedimentation chambers for Imhoff tanks. The first is a longitudinal horizontal-flow tank, and is the one most in use. The second is a downward-and-upward-flow tank. The third is a radial horizontal-flow tank.

The size of the settling-chamber depends principally upon the necessary detention period, upon the time allowed for the solids to settle, and upon the volume of sewage. The detention period depends upon the character of the sewage to be treated. The dilute sewage of the Pacific Coast community requires a longer detention period than the sewage that contains large quantities of suspended matters, or coagulating chemicals such as are present in many industrial wastes. The detention period for dilute sewage is, in general, taken as two hours. In nearly ever case over 95% of the solids capable of settling will be deposited in this time. More time than this may be dangerous in that the effluent may become stale and saturated with the offensive sewage gases, the products of anaerobic action. It is also necessary to limit the length of the

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settling-chamber flow-line, since if this is made too long the velocity necessary to give the proper detention period will be high enough to induce whirling currents, and thus hinder sedimentation. Experience has shown that an average velocity from 0.1 to 0.13 ft. per second is a reasonable maximum limit, above which whirling is liable to occur. In the design of Imhoff tanks it has been the practice not to exceed 0.03 ft. per second for dry-weather flow, so that the upper limit of 0.1 ft. is reached when the storm-water dilution is threefold. The flow-line may be made shorter than this, within limits, but it should not be made longer. To design tank dimensions solely from the standpoint of velocity or solely from the standpoint of detention period is not good practice. Both these factors should be considered together with the character of the sewage to be treated. With the length determined, the necessary tank volume will give the necessary cross-section. From the cross-section the width and depth may be determined. The minimum ratio of width to length that should be used for effective utilization of the tank is about 1:6, but may be made as much as 1:10. Fig. 3 shows approximately the direction, position, and intensity of the stream in the tank.

In general, the width and depth of the tank should be

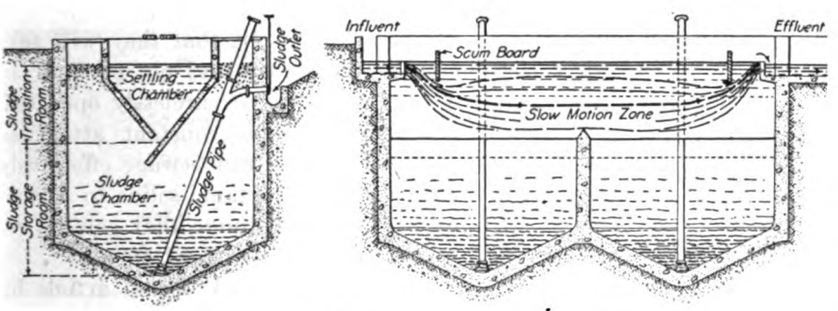

FIG. 3. SKETCH OF STREAM-FLOW IN TANK.

governed by the necessity of proper distribution of the flow. The movement of sewage in the settling-chamber should be studied intelligently. The tank should not be so shallow as to encroach upon the slow-motion zone and thus interfere with the passage of the settling particles through the slot, nor should it be so deep as to inhibit proper vertical distribution of the flow. In the former case, the maximum possible proportion of settleable solids will not be removed, and in the latter case, part of the volume of the tank will be ineffective. The width of the tank is also limited by the necessity of proper lateral distribution.

Inlet and Outlet. It is the usual practice to design an Imhoff tank so that the inlet and outlet may be interchanged. The flow is reversed periodically, thus a uniform rate of deposition is effected over the whole sludge-chamber.

Scum-Boards. Scum-boards are placed at the inlet and outlet ends of the settling-chamber. The one at the inlet end serves to collect the floating solids, such as the kitchen-grease particles, corks, and matches, and also to diffuse the flow. The one at the outlet end serves to hold back the lighter floating particles. These boards are placed at equal distances from the outlet and inlet, since they alternately serve to diffuse the raw sewage as it enters the settling-chamber. The penetration of these boards under the water should not be so great as to render part of the upper volume of the chamber ineffective, or to increase the velocity in the lower slow-motion zone immoderately. They are usually made to penetrate to a depth of 12 to 14 inches.

It is important that the settling sludge particles be given absolutely no opportunity of remaining shelved upon projecting surfaces. The upper surfaces of all parts of the settling-chamber, including the projecting pipes, are given an inclination of at least one and one-half vertical to one horizontal.

Sludge-Chamber. The sludge-chamber in the Imhoff tank should be considered as being composed of two parts, the part below the slot, or the sludge-storage room and the part above the slot and adjacent to the settling-chamber, which may be called the scum-transition room. The transition room accommodates the rising and falling particles and temporarily floating sludge-masses. Here, the scum relieves itself of the gas generated in the process of decomposition.

The size of the storage-room is determined by the population to be served, upon the character of the sewage, and upon the requirements of operation. It has been found that the amount of sludge discharged from the Imhoff tanks is from 0.0035 to 0.007 cu. ft. per inhabitant per day, in the case of the dilute sewage of the United States. Multiplying these figures by the number of inhabitants and the product by the number of days storage to be provided gives the capacity of the storage-room. It is usual to assume six to eight months for this storage period in California, which time produces a nearly odorless sludge. Properly decomposed sludge is black in color, and has a slight but not unpleasant odor like that of rubber or warm sealing-wax. It gives an alkaline reaction and is easily dewatered.

The depth of the sludge-digestion chamber influences the digestion process, but little is known definitely on this point. However, it is known that shallow tanks yield a poorer quality of sludge than deep tanks. A possible explanation of this may be found in the theory that the shorter the period that elapses when the fresh sludge particles come into intimate contact with the decomposed particles, the more quickly will they themselves decompose. It is obvious that the deeper the tank the more intense the gas development, and hence the more intense the stirring action. This should follow from the theory of 'inoculation,' which assumes that an organic particle, to be decomposed in the quickest and most odorless manner, must be inoculated as rapidly as possible with the proper bacteria. These

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bacteria can best be obtained from other sludge particles already decomposing properly. However, to bring about this condition, intimate contact, particle for particle is necessary, and this does not occur easily when fresh sludge is allowed to rest 'dead' in large masses. This may be the reason why the violent stirring action of the deep Imhoff tanks results in good sludge and odorless decomposition. It will be noted from the above that all the decomposing 'live' sludge mass in the sludge-digestion chamber should never be removed at any one time. Enough 'live' sludge particles should be allowed to remain to effect intimate contact with the freshly deposited material. This produces the most rapid and continuous process of decomposition. There is no ripening period necessary, as the process is continuous when operating under these conditions. Deep sludge-tanks form a sludge that is more rapidly dewatered than from shallower tanks. This is due to the fact that the small gas bubbles that form and are included in the sludge-mass are under considerable pressure when in deep tanks. On being removed from the bottom of the tank, the sludge is released from this greater pressure and the included bubbles expand. This expansion varies with the pressure at the bottom of the tank, and consequently with its depth. The expansion of the gas bubbles forms a porous sludge from which the water is drained readily. Sludge-tanks are usually given a total depth of about 25 ft., but the cost of construction as well as the desired depth must be considered when designing the sludge-chamber.

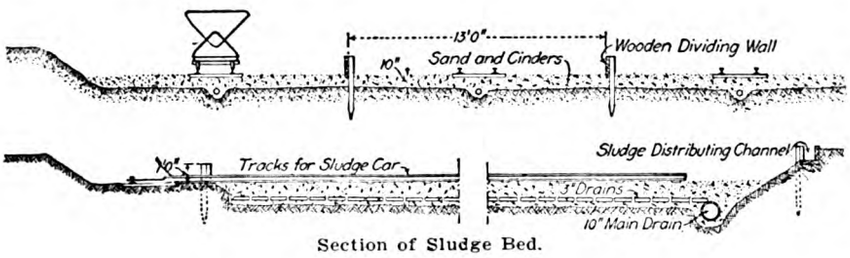

FIG. 4. APPROVED DESIGN FOR SLUDGE BED.

Sludge Discharge. Usually the sludge is discharged from the sludge-chamber by means of an 8-in. pipe, reaching nearly to the apex of the conical bottom of the tank and having its outlet far enough below the water-level to provide sufficient hydraulic head to move the sludge. Sludge should be discharged from the sludge-chamber once every two to six weeks. This procedure will effect the maximum utilization of the sludge-drying beds as well as aid the decomposition of the sludge. The sludge-digestion chamber operates at its best when the sludge level is about three feet below the slot level. To maintain this position it is necessary to remove the decomposed sludge frequently. In any case, the level of the sludge should never be allowed to rise above the edge of the inclined diaphragm which limits the slot. The elevation of the sludge surface may be determined by lowering into the sludge-chamber a thin piece of sheet-iron about 1 sq. ft. in area, held in a horizontal plane. The determination of the sludge in this manner cannot be relied upon absolutely, because the transition between sludge and supernatant liquid is often difficult to perceive. If the sludge level is allowed to become too great, gas bubbles will appear on the surface of the settling-chamber vertically above the slot. Care should be taken when sludge is being removed that it is not drained off too rapidly. The friction along the surface of the sludge-chamber may be great enough to permit the sludge surface to be sucked down so that water may enter the sludge-discharge pipe.

Sludge Drying Beds. Properly constructed underdrainage beds should be provided for the drying of the decomposed sludge. Ripe or thoroughly decomposed sludge, 12 to 16 in. thick, becomes spadeable in four to six days during ordinary dry weather. The area of a sludge-bed for a depth of wet sludge of 12 in. should be about 80 sq. ft. per 1000 inhabitants. The dry sludge is a fairly satisfactory fertilizer, its greatest value being the humus it furnishes to the soil.

In conclusion, it may be stated that the Imhoff tank represents the height of clarification and sludge-digestion development. These tanks are free from odor. This does not mean, however, that they will take care of themselves and not give off an odor if neglected or carelessly operated. But given a little constant attention, they will clarify raw sewage effectively and reduce the organic solids to a completely odorless sludge that can be removed easily and without offense.

[Editor's Note. A second article by Mr. Hammerly, on the operation of a sewage-disposal plant, will appear in an early number.]

The greatest erosive action of water is not when the flow is largest but rather on a falling gauge. The detritus carried by the maximum velocity is hardly a factor in controlling conditions of flow, the stream following the open channel along the line of least resistance. The moment the velocity commences to decline, the largest and heaviest boulders, or in the case of valley-streams, the sand and silt, are dropped on the floor of the channel, and the still comparatively rapid current, forced to follow a serpentine course, is deflected directly against the banks. The streams will then continue to take in suspension additional load until an entirely new regimen is acquired. This regimen is dominated first by the relative depth of the water, second by the width of the channel, and last by the grade. The widening of the stream by an increased separation of the banks at once lessens the depth and diminishes the velocity, with resultant deposits of suspended matter. Narrowing the stream, on the other hand, producing a scouring action.

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Engineers' Note Book

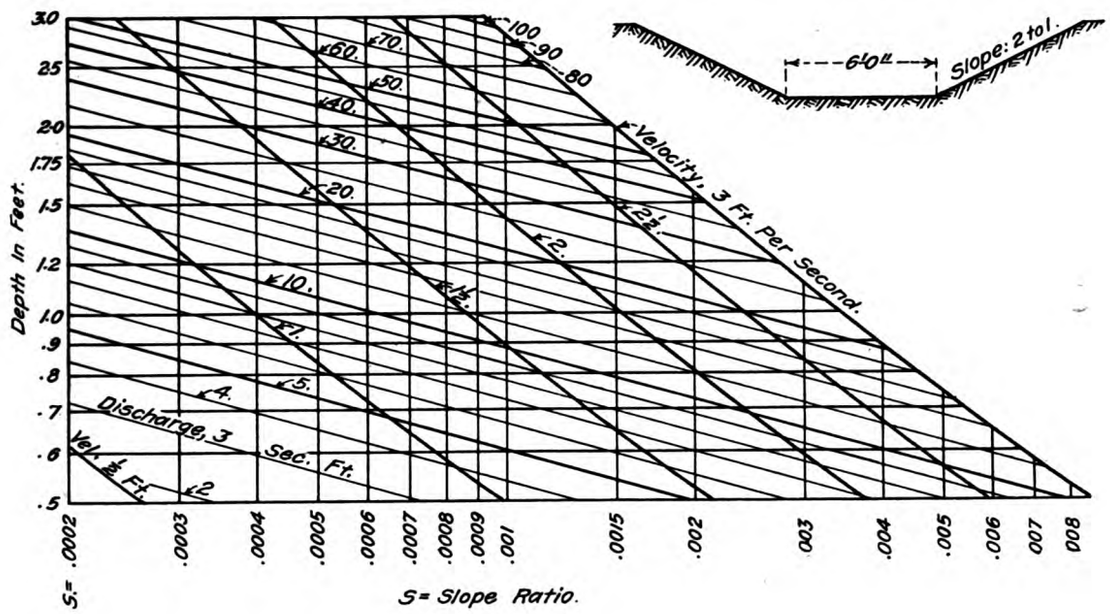
CHARTS FOR DETERMINING VELOCITY AND DISCHARGE IN EARTH DITCHES

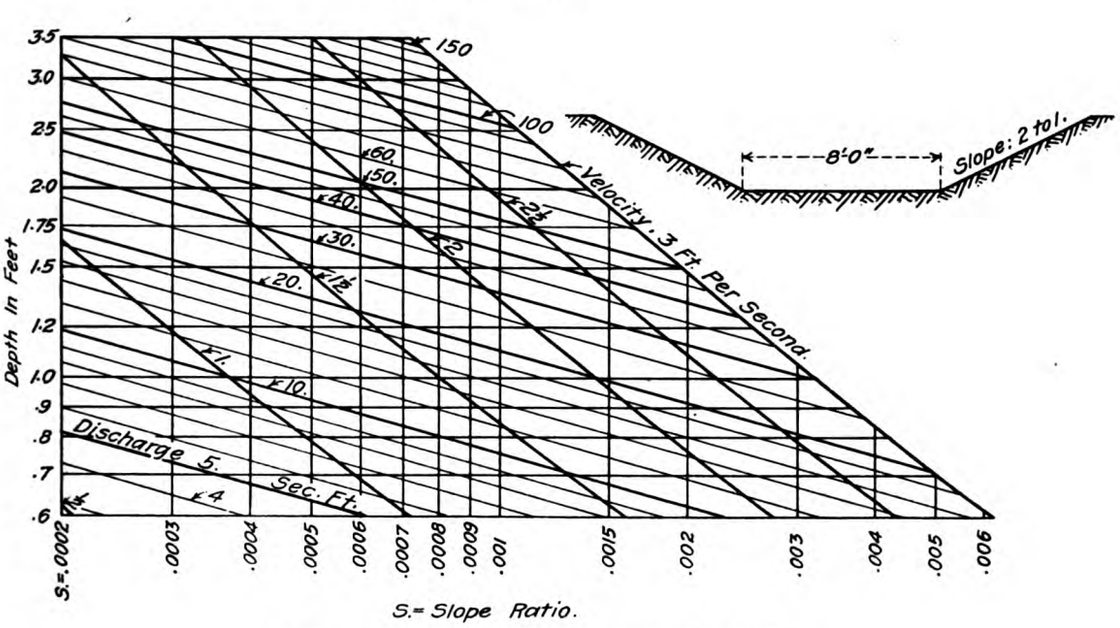
By GEORGE HENRY ELLIS*

The accompanying charts may be used for computing the velocity and discharge in small unlined earth ditches. Quantities have been computed by Kutter's formula, n being taken as 0.0225, an average value for earth canals in fair condition.

Thus for a canal 6 ft. wide flowing 2 ft. deep, with a slope of 0.0004 or practically 2 ft to the mile, the velocity is found to be approximately 1½ ft. per second and the discharge 30 cu. ft. per second. For a canal 8 ft. wide, flowing 3 ft. deep, with a slope of 0.0002 or 1 ft. to the mile, the velocity is slightly under 1½ ft. per second and the discharge is 60 cu. ft. per second. Again, given a canal 8 ft. wide, with a slope of 0.0009 or 4½ ft. per mile; required the depth of water to give a discharge of 50 cu. ft. per second. By interpolation, the depth is found to be approximately 1.85 ft. The velocity for this discharge is found by interpolation to be 2.3 ft. per second.

The diagram may also be used to solve such problems as, given a canal 6 ft. wide in which it is desired that the velocity be 2 ft. per second, what is the greatest depth that can be permitted in the canal without delivering more than 40 cu. ft. per second, and what would be the corresponding slope? The depth is found to be 2 ft. and the slope approximately 0.00066 or 3.3 ft. per mile. Again, given a canal 8 ft. wide flowing 2.5 ft. deep; required the slope necessary for a discharge of 50 cu. ft. per second, also the corresponding velocity. The slope is found to be slightly under 0.0003 or 1½ ft. per mile and the corresponding velocity is computed by interpolation to be 1.6 ft. per second. Similarly a canal of the same dimensions to deliver 60 cu. ft. per second would require a slope of 0.0004 and a velocity of 1.9 ft. per second.





CHARTS FOR COMPUTING DISCHARGE OF EARTH DITCHES.

*Fort Shaw, Montana.

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Book Reviews

THE MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1916. P. 330. Ill., index. The Norman Remington Co., Baltimore. For sale by *Mining and Scientific Press*, San Francisco. Price, 25 cents.

This is the twenty-ninth year of the publication of this valuable pocket-book. Some material has been added and other parts brought up to date. It contains a number of tables and other data, principally useful to the mechanical engineer, but of value to the engineer in other lines. A diary for 1916 is included. Altogether the purchaser certainly gets a great deal for his money.

DAMS AND WEIRS. By W. G. Bligh. P. 206. Ill., index. American Technical Society, Chicago. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.50.

This is a brief but fairly comprehensive treatise upon the subject. The design of gravity dams of masonry and concrete is first considered and examples with profiles given of a number of dams actually constructed. The effect of percolation under porous foundations is discussed. The next division is overfall dams and weirs, then single and multiple-arch dams, and hollow-slab buttress dams. Submerged weirs founded on sand and methods of preserving stability in spite of percolation are then considered. The last division is open dams or barrages. Earth dams are not considered anywhere in the volume. The book is well illustrated. It would have been made more interesting, at least, if the geographical situation of the various structures had been always given.

THE MECHANICAL ENGINEERS' POCKET-BOOK. By William Kent. Ninth edition, thoroughly revised with the assistance of R. T. Kent. P. 1526. Ill., index. John Wiley & Sons, Inc., 1916. For sale by the MINING AND SCIENTIFIC PRESS. Price, $5.

'Kent' needs no introduction to engineers and students; the work is always consulted; the appearance of a new edition (the last was in 1910) will be welcomed. There have been many changes and advances in engineering standards and practice during five years; this necessitated changing over 400 pages of the last edition, and an addition of over 150 pages of new matter. Many subjects previously discussed at length have been condensed. Materials, mechanics, blowers, heating and ventilation, fuel, steam-boilers and engines, and steam-turbines have been extensively revised. Machine-shop practice received considerable attention. Electrical engineering will be found up to date. A number of new tables are given. Internal-combustion engines are well treated. The variety of subjects included is too great to detail; they range from air to zinc.

MACHINE DESIGN. By Albert W. Smith and Guido H. Marx. P. 483. Ill., index. John Wiley & Sons, Inc., New York. For sale by the MINING AND SCIENTIFIC PRESS. Price, $3.

The authors are respectively director of Sibley College Cornell University, and professor of Machine Design in Leland Stanford Junior University. They say "One can never become a machine designer by studying books," and they quote John E. Sweet, who said, "It is comparatively easy to design a good new machine, but it is very hard to design a machine that will be good when it is old."

The present volume is the fourth edition revised and enlarged. Among the chapter headings are: cams; riveted joints; bolts and screws; sliding surfaces; axles, shafts, and spindles; journals, bearings, and lubrication; roller and ball-bearings; couplings and clutches; belts, ropes, brakes, and chains; fly-wheels and pulleys; toothed wheels or gears; springs.

The style is clear and thorough, with a sufficient number of tables, diagrams, and formulæ to make the matter inclusive, but not too many to get in each other's way; altogether a well-arranged treatise of a subject difficult to discuss in its entirety.

ENGINEERING GEOLOGY. Second edition. By Heinrich Ries and Thomas L. Watson. P. 679. Ill., index. John Wiley & Sons, Inc., New York. For sale by the MINING AND SCIENTIFIC PRESS. Price, $4.

The authors are respectively Professor of Economic Geology in Cornell University, and Professor of Economic Geology in the University of Virginia and State Geologist of Virginia. Professor Ries is, of course, well known for his writings on clays and building-stones. This second edition of the book makes the total issue 4000. Only 40 pages are given to ore deposits, and 50 to historical geology. There is much on building-stone, clay, coal, petroleum, and limestone. The chapters on structural and dynamic geology are particularly good; folding and faulting of rocks in their relation to engineering operations, such as tunnelling, are timely points, the importance of which is often overlooked. The chapter on rock-forming minerals is clearly written for the purpose of aiding the engineer in his practical work, as is the portion devoted to rocks. In fact, the manner in which the entire treatment of geology in its different aspects has been kept to the purpose of serving the engineer is commendable. While the book has not been aimed particularly at mining engineers, it is unmistakably a valuable work for engineers in general, representing a maximum of practical knowledge in an interesting manner, with a minimum of inapplicable material.

REINFORCED CONCRETE CONSTRUCTION. By George A. Hool. Vol. III. Bridges and Culverts. P. 684. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $5.

This is probably the most comprehensive and useful treatise in English that has appeared upon the subject. Part I deals with the arch bridge. The calculation of stresses by the theory of elasticity is explained, together with the use of both influence lines and the ellipse of elasticity. Particular cases such as the design of unsymmetrical arches and those with elastic piers are discussed. Chapters are devoted to details of arch bridges and to construction of arch bridges. The design of the three-hinged arch by both the usual and the influence-line method is explained. The chapter devoted to patents is particularly useful in view of the number of patents which interfere with the free use of results of research in this field of engineering design. A large number of typical designs of arch bridges and details are then given. Part II is devoted to slab and girder bridges and includes chapters on slab bridges, simple and continuous-girder bridges, and cantilever bridges. Another chapter deals with the use of reinforced concrete in the construction of piers and of solid floors in ordinary steel-bridge construction. Part III discusses culverts, separate chapters being devoted to the calculation of the proper waterway for a given drainage area, and to pipe, box, and arch culverts. The rest of the book is contributed by other authors and concerns particular portions of the subject with which they were especially qualified to deal. Thus A. W. Ransome, a concrete-machinery manufacturer, contributes some valuable data on construction plant. L. H. Allen, connected with a construction company, discusses estimating. W. J. Titus considers the subject of artistic design. A. M. Wolf, a constructing engineer, describes in detail the methods of construction of several large reinforced concrete bridges. Another chapter, written by Philip Aylett and P. J. Markmann, is devoted to European concrete bridges, and shows that while the American engineer probably excells in methods of construction, he has much to learn from his European brother in theoretical design and in aesthetic treatment. The last chapter is devoted to hinges for arched bridges. The book is well and almost profusely illustrated.

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THE CORROSION OF IRON. By L. C. Wilson. P. 178. Index. The Engineering Magazine Co., New York, 1915. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

In recent years considerable investigation has been directed to trouble from corrosion, involving chemical research of no simple character. Results of these tests have been published by technical journals and societies, and are therefore difficult to obtain. This book contains a collection of the more important facts connected with the corrosion of iron and steel, and their protection from it. The rust problem is of great importance to constructing engineers and others. The three principal theories of corrosion are the hydrogen peroxide, carbonic acid, and electrolytic; these are well discussed. Various elements added to iron help to prevent corrosion, so do the many processes of coating with metals and paints. Engineers of all professions will find this volume of practical value in the solution of many problems.

INDUSTRIAL USES OF FUEL OIL. By F. B. Dunn. P. 232. Ill., index. Technical Publishing Co., San Francisco. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

The use of petroleum as a commercial fuel is still a comparatively new thing and there is but little technical literature upon the subject. The first chapter of the present volume discusses the heating value and other physical properties of fuel oil, comparing it especially with coal. The next chapters consider general arrangements and devices for oil burning, including pumping and storage systems, arrangement of furnaces, oil burners, strainers, and heaters. The use of oil in particular industries is then discussed, the clay, lime, cement, sugar, gas, rubber, and steel industries are taken up in turn, besides the use of oil in smelting and other metallurgical work, for locomotives, steamships, and for domestic purposes. The use of crude oil in Diesel engines is not considered. Considerable data are given regarding comparative costs of the use of oil and other fuels, and there are directions given for tests and reports on fuels.

PRINCIPLES AND PRACTICE OF COST ACCOUNTING. By F. H. Baugh. P. 166. Index. F. H. Baugh, Baltimore. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

There is a familiar story concerning the man who installed a cost-keeping system in his factory, but who was unable to tell whether or not it helped his business because the entire force had been obliged to suspend business to work on the cost system. With due allowances for exaggeration, it is undoubtedly true that many manufacturers have failed to get the best returns from their plants because cost systems seemed to them nothing but a useless mass of printed forms and filing-cases. The author of the present volume has wisely confined himself to an explanation of the principles underlying cost keeping with only enough concrete examples to illustrate these principles, leaving the arrangement of details for a particular factory to the reader. As a further aid to clearness, 'efficiency engineering,' or as the author prefers to call it, 'factory management' is separated from cost-keeping and the latter subject only is discussed. The chapter headings are: Financial Accounting; Principles of Cost Accounting; Specific Job Cost; Department Cost; Process Cost; Departmental Cost Accounts; and Illustration of Process Cost. Both table of contents and index are unusually full and well arranged. The book should be useful to the factory manager and to others interested in cost accounting.

CONCRETE. By John C. Trautwine, Jr., and John C. Trautwine, 3d. P. 126. Ill., index. Trautwine Co., Philadelphia. For sale by the *Mining and Scientific Press*, San Francisco. Price, $1.

This book contains the portions of the 'Pocket-Book' that relate to concrete. The first section reprinted is on strength of materials; the next sections are, in order, cement, sand, mortar, concrete, and reinforced concrete. The notes on the last named, while necessarily condensed, contain a good summary of the principles of design in that material. Next comes a division on experiment and practice, which contains a summary of the data obtained concerning concrete and related subjects by a number of observers. Divisions on specifications and on cost data are included and there is also a price-list, bibliography, and index. The book should be of as much value to those interested in concrete construction as the regular pocket-book is to engineers in general.

IRRIGATION PRACTICE AND ENGINEERING. By B. A. Etcheverry. Volume III. Irrigation Structures and Distribution. P. 421. Ill., index. McGraw-Hill Book Co., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.

This is the third and concluding volume of the author's series. Volume I on 'Use of Irrigation Water and Irrigation Practice' was reviewed in WESTERN ENGINEERING for October 1915 and Volume II on 'Conveyance of Water' in January 1916. Taken as a whole, the treatise is probably the most complete and useful of any of those which deal with the subject. This is particularly true with regard to North American practice, although many examples are taken from irrigation systems in other parts of the world. The present volume begins by discussing diversion works, from the primitive brush and cobble weirs still common in regions where water is cheap to the concrete structures in use on the more up-to-date systems. The various minor parts of the diversion works such as scouring sluices, fish-ladders, and log-ways are then considered. Headgates, spillways, and sand-boxes are taken up in order. Crossings with drainage channels and drops and chutes are discussed. The next chapter deals with the general features of a distribution system. The particular structures of a distribution system, such as check-gates, head-gates, and road and railroad crossings, are then discussed. The next chapter considers special types of distribution systems, such as wooden flumes, wood-stave pipes, and cement pipes. The last chapter is devoted to measuring devices which are suitable for use with irrigating water. The book is well illustrated and there is a good index.

ENGINEERING AS A CAREER. Edited by F. H. Newell and C. E. Drayer. P. 214. D. Van Nostrand Co, New York, 1916. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.

This is a symposium on a much discussed subject, the contributors being A. J. Hines, Franklin De R. Furman, Worcester R. Warner, A. W. Johnston, Chester W. Larner, J. H. Herron, W. H. Abbott, M. C. Whitaker, S. T. Wellman, J. C. Workman, R. Winthrop Pratt, Robert Hoffmann, Rudolph Blankenburg, Frank C. Osburn, Benjamin S. Hubbell, F. B. Richards, Henry S. Munroe, Ernest McCullough, James F. Barker, Waldemar Kaempffert, David Edgar Rice, and John Ritchie, Jr., who discuss the engineer, boys becoming engineers, mechanical, railway, hydraulic, metallurgical, electrical, chemical, marine, sanitary, municipal, bridge, architectural, and mining engineering, also iron and steel opportunities for mining engineers, the lure of private practice, vocational guidance, income of technically trained men, and the technical man in business. Most of these articles were published in the Cleveland *Plain Dealer* and *Scientific American*. The inspiration for the book came in response to numerous inquiries from high school teachers and others who are frequently called upon to advise young men in their choice and preparation for a professional life. It was found from experience that many youths who planned to study engineering had only the most hazy ideas of what is involved, nor were their teachers and parents much better informed. The book should prove of special value to professional advisers in vocational guidance work and to parents who have the opportunity of continued observation and intimate acquaintance from which may be learned the aptitudes of their sons.

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Hints on Practice

DRIVING-BELTS

Most users of dynamos and motors have experienced belt troubles from breaking, slackening, or slipping. A good belt should be made so that when a joint is made while the belt is in its place, it will present the appearance of an endless belt. After having been taken up once or twice during the first year, good belts, require little attention, with the exception of being kept clean and lubricated, during the subsequent years of their life.

All belts having much work to do, ought to present a clammy face to the pulley, and this condition is best maintained by applying one coat of dubbing and three coats of boiled linseed oil once a year. This oil oxidizes, and the gummy surface gives the belt a smooth, elastic driving-face. A belt treated in this way will run well if slack, and the wear and tear will be inconsiderable. On the other hand, dry belts have to be kept tight, or they will slip and refuse to do the work. The friction between the driving pulley and the belt burns the belt as long as the slipping continues.

By running the grain or smooth side next to the pulley there is considerable gain in driving power. However, by using boiled linseed oil, as before mentioned, the flesh side will soon become as smooth as the grain side, and the driving power will be just as good. A belt working with the grain side next to the pulley really has a much shorter life than the belt running on the flesh side. The reason is that the first is working against the natural growth of the hide, while the other is working according to nature. If you take a narrow cutting of belt leather, pull it well, and lay it down, you will at once observe that it naturally curves flesh side inwards. Nature, therefore, as a teacher, tells us to run the flesh side next the pulley, and practice proves this to be correct.

Whether the belts are new or old, a properly made joint is of the first importance to all users of belting. A well-made butt joint with the lace holes punched in a diamond-shaped row answers the purpose fully as well as any. Care should be taken that the holes do not come in a line across the belt, as this weakens the belt considerably, especially when the holes are fairly close together. A good lace, properly applied, will last a long time and will cost but little. If a lap joint is made, time should be taken to thin down the ends of the lap. Joints of this sort should be made to the curve of the smallest pulley over which the belt has to travel.

Dust should never be allowed to gather into a cake on the pulley or the belt, for if it does, the fibre of the leather is strained. Good belts lubricated carefully and run as slack as possible without slipping, give good service. Tight, dry belts are not so economical, because the bearings get hot, which makes the shafting harder to turn. Such a belt may leave the pulley or break, or slip so as to endanger its life. If an accident happens because of the belt coming off or breaking, those in charge will take time consulting as to what should be done. Meanwhile, the cause of the trouble gets time to cool, and the source of annoyance is never discovered. Before a new start is made, the bearings are well lubricated. All goes smoothly, yet someone is blamed for the breakdown—*Mechanical World.*

STOPPING LEAKS IN BOILER SETTINGS

Excess air in stack gases, which is manifested by a low percentage of CO_2, lowers both the efficiency and the steaming capacity. The efficiency is lowered because of the heating of unnecessary air that leaks through the walls of the furnace and carries away heat which otherwise would be transferred to the boiler. The steaming capacity is reduced because of the reduction in effective draught by such air seepage, as well as by the loss of heat. Attention has been called to the importance of going over the boiler-setting carefully and stopping up all cracks, especially those where brick and iron come together which are likely to go unnoticed. Piecemeal stopping of cracks and crevices, however, stops only part of the avoidable air seepage into the furnace. Another method is to cover the whole setting with something that is not porous, such as a steel jacket. This is rather expensive in first cost, is troublesome to remove and replace when repairs are necessary, and hardly suitable for small boiler plants, where covering is most needed. The most satisfactory method, according to my experience, is to cover the brickwork and joints of the setting with heavy cotton sheeting or very light canvas, the former being preferable. The sheeting may be applied like wall-paper with rye-flour paste. After it has been applied a suitable filling will prevent the air seepage. This filling can be done either with the paste or with an application of water-glass (sodium silicate) as a paint. This stops up the cracks and pores wholesale, and does it cheaply and effectually. The cost of this covering is so small that its destruction to make repairs to the boiler setting is a small matter. Although the stopping of air seepage into the setting is one of the first and most important steps in securing boiler efficiency, it is by no means the only step, and must be considered along with a number of other operating precautions if substantial improvements in economy are to be made.

Often when such covering is put over brickwork of a boiler setting it will be found that the brickwork feels warmer to the hand than before. While this may indicate at first thought an increased radiation loss, it is in reality the best evidence possible that the covering is doing the work for which it was intended. The seepage of air through the brickwork no longer cools it, and consequently the heat which was formerly carried along with the inflowing air into the furnace and up the chimney is now conducted through the brickwork and radiated from the covering. However, these radiation leaks are not serious, and the losses caused by them are small compared with the losses caused by the infiltration of air. Lagging the boiler setting to stop radiation losses has been suggested and used, and it is probable that the gain in economy and capacity resulting upon the stoppage of air infiltration by such a lagging is more important in dollars and cents than the stopping of radiation losses from the setting.—J. R. Cravath in *Electrical World.*

New Publications

U. S. Bureau of Mines, Washington, D. C., 1915:

SAMPLING AND ANALYSING FLUE-GASES. By Henry Kreisinger and F. K. Ovitz. Bulletin 97. P. 70. Ill., index.

Results of investigations into the important subject of efficiency in boiler-plants. This is written in non-technical language, and is practical, so should be secured by steam-users.

MANUFACTURE AND USES OF ALLOY-STEELS. By Henry D. Hibbard. Bulletin 100. P. 77. Index.

This is also a valuable treatise on steels now much in demand.

THE LIMITS OF INFLAMMABILITY OF MIXTURES OF METHANE AND AIR. By G. A. Burrell and G. G. Oberfell. Technical Paper, 119. P. 30. Illustrated.

This paper is one of a series dealing with the causes of mine explosions, and discusses experiments made on self-propagation of flame in mixtures of methane and air, and shows the composition of some coal-mine atmospheres.

QUARRY ACCIDENTS IN THE UNITED STATES DURING 1914. Compiled by Albert H. Fay. Technical Paper 128. P. 45.

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Out of 87,936 men employed, who worked 20,456,157 shifts, there were 180 killed, equal to 2.05 per 1000, an increase of 0.33 per 1000.

U. S. Geological Survey, Washington, D. C., 1915:

THE PUBLIC INTEREST IN MINERAL RESOURCES. By George Otis Smith. P. 9.

An instructive talk on a great industry.

GOLD AND SILVER IN 1914. General report. By H. D. McCaskey. P. 37.

Metallurgists and statisticians will find valuable data in this paper.

LEAD IN 1914. General report. By C. E. Siebenthal. P. 29. Illustrated.

PETROLEUM IN 1914. By John D. Northrop. P. 206.

The production of over 290,000,000 bbl. and all details of an important industry are discussed.

THE PEOPLE'S INTEREST IN WATER-POWER RESOURCES. By George Otis Smith. Water-Supply Paper 400-A. P. 8.

The author states that the people's interest in water-power is served only through use.

CASSITERITE IN SAN DIEGO COUNTY, CALIFORNIA. By Waldemar T. Schaller. Bulletin 620. P. 4. Map.

GEOLOGY AND COAL RESOURCES OF NORTHERN TETON COUNTY, MONTANA. By Eugene Stebinger. Bulletin 621-K. P. 40. Maps.

OIL AND GAS NEAR BASIN, BIG HORN COUNTY, WYOMING. By Charles T. Lupton. P. 44. Maps, chart.

PRELIMINARY REPORT OF THE ECONOMIC GEOLOGY OF GILPIN COUNTY, COLORADO. By Edson S. Bastin and James M. Hill. Bulletin 620-M. P. 29. Maps.

NATURAL-GAS RESOURCES OF PARTS OF NORTH TEXAS. Chapters by Eugene Wesley Shaw, George Charlton Matson, and Carroll H. Wegemann. Bulletin 629. P. 126. Ill., maps.

DISCOVERY OF PHOSPHATE OF LIME IN THE ROCKY MOUNTAINS. By Frank D. Adams and W. J. Dick. P. 36. Ill., index. Commission of Conservation, Ottawa, Canada, 1915.

This deposit was found near Banff, Alberta. Some useful hints on prospecting for this mineral and testing are given.

GEOLOGY AND UNDERGROUND WATERS OF THE NORTHERN LLANO ESTACADO. By Charles Laurence Baker. University of Texas Bulletin No. 57. P. 225. Ill., maps, charts, index. Austin, 1915.

SURFACE OILING OF EARTH ROADS. Bulletin No. 11. Illinois State Highway Department, Springfield, Illinois. Tells of the purpose of oiling, describes the selection and preparation of the roads for oiling, and gives directions for applying the oil. The questions of shipping and handling the oil are discussed at some length. The bulletin also gives as much cost data as in available at the present time. The application of oil on gravel and macadam roads is also briefly discussed. The purpose of the bulletin is not to cover in detail all that might be said in regard to oiling earth roads, but rather to give a general outline of the subject together with suggestions as to the best methods for oiling and maintaining earth roads.

Engineering Societies and Conventions

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

Coming Conventions

NATIONAL ELECTRIC LIGHT ASSOCIATION. Annual convention, Chicago, week beginning May 22. T. C. Martin, secretary, 29 West 39th street, New York.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS. Third annual convention, Montreal, March 6-10.

Personal

JOSEPH M. TRACY has been appointed city engineer of Ogden, Utah.

G. N. ADAMS has been appointed city engineer of Tropico, California.

FRANK TROTT, of Phoenix, has been appointed surveyor general for Arizona.

B. L. DORMAN has been re-appointed city engineer of Vancouver, Washington.

E. W. CLARK has been appointed general manager for the Union Oil Company.

C. E. GRUNSKY has been re-elected president of the California Academy of Sciences.

JAMES T. NARBETT, of Richmond, California, has opened a branch architectural office at Vallejo.

EDWIN DURYEA, JR., of San Francisco, has been elected director of the American Society of Civil Engineers.

E. G. MACDONALD has been appointed chief engineer for the Oakland division of the Great Western Power Company.

EDWIN T. MCMURRAY has been elected president, and E. H. MAGGARD, general manager, for the Petaluma & Santa Rosa Railway Company.

W. J. ROBERTS has been re-appointed chief engineer for the inter-county river improvement work in King and Pierce counties, Washington.

ALLAN R. SCOTT, superintendent of the municipal asphalt division at Spokane, Washington, has resigned in order to engage in contracting.

D. W. COLE, project engineer for the United States Reclamation Service, with headquarters at Fallon, Nevada, has been transferred to Boise, Idaho.

WALTER M. BERRY, of Portland, Oregon, has been appointed assistant gas engineer for the Bureau of Standards, with headquarters at Washington, D. C.

LUTHER WAGONER, consulting engineer of San Francisco, has been appointed chief engineer in charge of sewer and pavement construction in Havana, Cuba.

CHARLES F. STERN, of the California State Highway Commission, addressed the Commonwealth Club of San Francisco on February 26 on 'The State's Highways.'

JOHN S. EASTWOOD has been appointed consulting engineer for Salt Lake City in connection with the construction of Parley's Canyon dam for the city water supply.

H. H. BARTER, formerly director of works at the San Diego Exposition, has been appointed head of the technical depart-

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ment of the Universal Film Manufacturing Co. at Universal City, California.

R. B. WOOLVERTON, United States radio inspector for the district including California, Utah, Nevada, Arizona, and Hawaii, has resigned to become engineer for the Federal Telegraph Company.

C. P. BOWIE, formerly engineer for the Associated Pipe Line Co., has resigned that position to become petroleum engineer for the United States Bureau of Mines. His headquarters will be in San Francisco.

The following officers have been elected by the Seattle Association of the members of the American Society of Civil Engineers: president, A. O. POWELL; vice-president, JOSEPH JACOBS; secretary and treasurer, CARL H. REEVES.

GEORGE W. BOSCHKE, formerly chief engineer for the Oregon-Washington Railway & Navigation Co., has been appointed chief engineer for the California & Oregon Coast railway, now being built from Grants Pass, Oregon, to Crescent City, California.

FRANK E. WEYMOUTH, who has been connected with the United States Reclamation Service in various capacities for the past 13 years, has been appointed chief of construction for the Service, succeeding SYDNEY B. WILLIAMSON, who resigned.

E. B. LATHAM, deputy state oil and gas supervisor for the Santa Maria, California, oilfields, has resigned on account of private business. He has been succeeded by R. E. COLLUM, who has been assistant to CHESTER NARAMORE, deputy supervisor for the Midway-Sunset fields.

W. A. CATTELL, consulting engineer of San Francisco, who has been in Honolulu appraising the properties of the Honolulu Rapid Transit & Land Co., has completed that work and has been retained by the Oahu Railway & Land Co. to make a valuation of its physical properties.

The American Road Builders' Association has elected the following officers for the coming year: president, E. A. STEVENS; first vice-president, ARTHUR W. DEAN; second vice-president, A. B. FLETCHER; third vice-president, W. H. CONNELL; secretary, E. L. POWERS; and treasurer, W. W. CROSBY.

PAUL P. WHITHAM and L. EVANS have organized the Industrial Engineering Co. to engage in consulting practice, with offices in the New York Block, Seattle, and 725 Commerce street, Tacoma. Mr. Whitham was formerly chief engineer for the port of Seattle. Mr. Evans is an electrical engineer.

The following officers have been elected by the Engineers and Architect Association of Southern California: president, A. H. KOEBIG; first vice-president, A. S. BENT; second vice-president, I. J. FRANCIS; secretary-treasurer, H. Z. OSBORNE, JR.; directors, J. J. BACKUS, A. C. MARTIN, C. P. ROBINSON, and H. L. SMITH.

The Inland Waterways Association of California has elected the following officers for the coming year: president, CHARLES M. ELLIOTT, San Francisco; first vice-president, R. H. NORTON, Los Angeles; second vice-president, Mrs. E. G. GREEN, Stanford University; third vice-president, M. E. DITTMAR, Redding; fourth vice-president, JOHN FAIRWEATHER, Fresno; treasurer, J. L. CRAIG, Stockton; secretary, CRAGIE SHARP, Oakland; assistant secretary, DAVID B. LIVINGSTON, Long Beach.

Obituary

JOHN M. ESHLEMAN, lieutenant governor of California, died February 28, at Indio. He was born at Villa Ridge, Illinois, in 1876 and came to California in 1896. After working on a railroad section-gang for two years, he entered the University of California, graduating in 1902. Soon after, he was admitted to the bar, and was appointed deputy State Labor Commissioner. In 1906 he was elected to the Assembly from Alameda county. During the first session of the legislature his health broke down and he was obliged to go to the Imperial valley to regain it. He was elected district attorney of Imperial county, and in 1910 was elected State railroad commissioner. It was as chairman of the Commission from 1910 to 1914, that he performed his most conspicuous public service, becoming an authority on corporation regulation. In 1914 he was elected lieutenant governor. The tubercular difficulty which had troubled him for several years finally resulted in the hemorrhages that caused his death.

Commercial Paragraphs

Maynard D. Church has been appointed chief engineer for the TERRY STEAM TURBINE Co., of Hartford, Connecticut.

Thomas F. Williams has been appointed consultant of the board of engineering research of the POWDERED COAL ENGINEERING & EQUIPMENT Co. of Chicago and will direct the research work of the company in the carburization of comminuted fuel.

C. F. BRAUN & Co., of 503 Market street, San Francisco, announce that they have made arrangements to manufacture locally a large part of the apparatus sold by them and formerly supplied from the East, including feed-water heaters, water softeners, filters and sterilizers, expansion-joints, cooling-towers, etc.

The BUCYRUS Co. announces the following changes: S. E. Elmore, formerly central sales manager for the company will become superintendent of its Evansville plant. E. C. Hingston will succeed Mr. Elmore, and will in turn be succeeded as Western sales manager by G. H. Hutchinson. Mr. Hutchinson's territory will include California, Nevada, Utah, and Arizona, with headquarters at 806 Merchants National Bank Bdg., San Francisco. L. T. Russell will continue as Northwestern sales manager, with territory including Washington, Oregon, Idaho, and western Montana, with headquarters at 608 Pittock Block, Portland.

Catalogues Received

Bulletin No. 43253. The GENERAL ELECTRIC Co., Schenectady, New York. Series Luminous Arc Lamps. P. 16. Ill. Describes lamps of this type.

Bulletin No. 48017, The GENERAL ELECTRIC Co., Schenectady, New York. P. 4. Ill. Describes the application of electricity in the harvesting of natural ice.

Bulletin No. 47409. The GENERAL ELECTRIC Co., Schenectady, New York. Small Capacity Industrial Switches. P. 8. Ill. General description of such switches, including prices.

Bulletin No. 210. The LYONS ATLAS Co., Indianapolis, Indiana. P. 4. Ill. Describes a portable two-stage gasoline or kerosene-driven air-compressor recently designed by the company.

EMERSON STEAM PUMPS. The Emerson Pump & Valve Co., Inc., Alexandria, Virginia. P. 16. Contains a number of letters from contractors, engineers, and others relative to their experience with the pumps manufactured by the company.

Bulletin No. 11. The BACON-RAPID PORTABLE ASPHALT PLANT. The Edward R. Bacon Co., San Francisco and Los Angeles. P. 8. Ill. Describes the portable mixer manufactured by the company, which can be used either as an asphalt or a cement concrete mixer.

THE BUCKEYE JUNIOR TRACTION DITCHER. The Buckeye Traction Ditcher Co., Findlay, Ohio. P. 4. Ill. Describes a small ditch machine cutting a trench 10 in. wide and up to 40 in. deep. Also a 16-page illustrated bulletin giving data regarding the performance of other ditchers manufactured by the company.

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SAN FRANCISCO, MARCH 6, 1916

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Construction Summary

Construction activities in California during February were mainly concerned with the repair of damage resulting from the storms of January. After being closed to traffic for nearly four weeks, the Atchison, Topeka & Santa Fe line from Los Angeles to San Diego was reopened on February 18. Other railroads were running on time early in the month and are now devoting their energies to strengthening roadbed and replacing temporary bridges. A bond issue of $175,000 is proposed in Orange county for construction of concrete culverts and bridges in place of those that have been destroyed. San Diego county is also considering a bond issue for the construction of steel bridges on the most important highways, and either pile bridges or concrete fords on the other roads. Repairs will be made to the highways themselves from this issue, but no new construction will be attempted unless absolutely necessary, and no hard-surfaced road will be constructed. Work is already under way for the repair of the various conduits of the water system of the city of San Diego. A contract has already been awarded for laying a wood-stave pipe-line from the Upper Otay to the Lower Otay dam and plans are under way for the repair of the Dulzura conduit. No definite plan has been proposed for the reconstruction of the Lower Otay dam, which failed on January 27, nor is it certain that it will be rebuilt at all.

State highway work in California is slowing down perceptibly, pending the result of the election next November on the proposed additional bond issue of $15,000,000. There is about $4,000,000 left of the original issue and this will be used mainly for completing work now under way. The first contracts have been awarded on the $1,000,000 highway system in Ventura county. Bond issues for highway systems are now under discussion in several counties.

Reconstruction of the nearly two thousand derricks and other structures in the San Joaquin Valley oilfields destroyed by the windstorms of January 17 and 27 is progressing. It is stated that 325 carloads of lumber were received in the fields.

In the Northwest, snow and unusually cold weather have delayed the spring opening of construction. Contract for the $600,000 irrigation system of the Suttles Lake irrigation district in Oregon has been awarded to the H. J. Kaiser Co., of Everett. The general contract for the Portland municipal auditorium, the most important building contract for the month, has been awarded to Hans Pederson, of Seattle, for the sum of $320,000.

During the month of January, the two United States Government dredges working on the Sacramento river between Collinsville and Rio Vista removed 861,353 cu. yd. of material. At the convention of the Inland Waterways Association of California recently held at San Francisco, it was brought out that this work is not only relieving flood conditions in the Sacramento valley, but is also helping to solve the same problem along the lower San Joaquin river. Until recently the channel near Collinsville was inadequate to carry the flood-waters of the Sacramento river, and these were backed up through various channels, particularly Georgianna slough, into the San Joaquin, and in some cases, even the Mokelumne river. During the January storms, on the other hand, the current in these sloughs was toward the Sacramento river enabling the San Joaquin and tributary streams to handle only their own flood-waters.

Contracts Pending

Bids will be Received		See Issue of News Bulletin
Mar. 6.	Fresno, Cal., Lighting System	Mar. 6
Mar. 6.	Fresno, Cal., Street Work	Mar. 6
Mar. 6.	Los Angeles, Cal., Gate Valves	Mar. 6
Mar. 6.	Los Angeles, Cal., Sewers	Mar. 6
Mar. 6.	Los Angeles, Cal., Street Work	Mar. 6
Mar. 6.	Redwood City, Cal., Concrete Culvert	Feb. 28
Mar. 6.	San Jose, Cal., Sewer	Mar. 6
Mar. 6.	San Rafael, Cal., Bridges	Feb. 21
Mar. 6.	Santa Barbara, Cal., Bridges	Feb. 28
Mar. 7.	Alameda, Cal., Building	Feb. 28
Mar. 7.	Alameda, Cal., Street Work	Feb. 7
Mar. 7.	Ephrata, Wash., Road Work	Mar. 6
Mar. 7.	Davenport, Wash., Road Work	Feb. 21
Mar. 7.	Kalama, Wash., Drainage	Mar. 6
Mar. 7.	Merced, Cal., Building	Feb. 28
Mar. 7.	Monterey, Cal., Street Work	Feb. 28
Mar. 7.	Pasadena, Cal., Street Work	Mar. 6
Mar. 7.	San Rafael, Cal., Road Work	Feb. 21
Mar. 7.	Stockton, Cal., Sewer	Mar. 6
Mar. 8.	Fresno, Cal., Road Oil	Feb. 21
Mar. 8.	Helena, Mont., Bridge	Mar. 6
Mar. 8.	Oroville, Cal., Road Work	Feb. 28
Mar. 8.	Seattle, Wash., Building	Feb. 14
Mar. 8.	South Bend, Wash., Bridge	Mar. 6
Mar. 8.	Washington, D. C., Pumps	Mar. 6
Mar. 9.	Helena, Mont., Bridge	Mar. 6
Mar. 9.	Sacramento, Cal., Sewer	Mar. 6
Mar. 10.	Fort Laramie, Wyo., Irrigation	Feb. 21
Mar. 10.	Helena, Mont., Bridge	Mar. 6
Mar. 10.	Ketchikan, Alaska, Steel	Feb. 7
Mar. 10.	North Bend, Wash., Building	Feb. 28
Mar. 11.	Chehalis, Wash., Bridge	Mar. 6
Mar. 13.	Ontario, Cal., Street Work	Feb. 28
Mar. 13.	Richmond, Cal., Sewers	Mar. 6
Mar. 14.	Modesto, Cal., Road Work	Feb. 21
Mar. 14.	Raehiti, New Zealand, Generator, etc.	Feb. 7
Mar. 14.	San Francisco, Cal., Air-Compressors	Feb. 28
Mar. 14.	Sausalito, Cal., Street Work	Mar. 6
Mar. 14.	Washington, D. C., Misc. Equipment	Feb. 28
Mar. 15.	Malta, Mont., Irrigation Work	Feb. 28
Mar. 15.	Salt Lake City, Utah, Water Mains	Mar. 6
Mar. 15.	Seattle, Wash., Dredging	Feb. 28
Mar. 16.	Oakland, Cal., Street Work	Mar. 6
Mar. 16.	Seattle, Wash., Coal	Feb. 28
Mar. 17.	Grass Valley, Cal., Building	Mar. 6
Mar. 18.	Boise, Ida., Bridge	Mar. 6
Mar. 20.	Colfax, Wash., Road-Oiler	Mar. 6
Mar. 20.	Olympia, Wash., Road Work	Mar. 6
Mar. 20.	San Bernardino, Cal., Buildings	Mar. 6
Mar. 21.	Turlock, Cal., Grading	Feb. 28
Mar. 22.	Tacoma, Wash., Buildings	Mar. 6
Mar. 22.	Washington, D. C., Building	Feb. 21
Mar. 29.	St. Ignatius, Mont., Canals	Mar. 6
Apr. 1.	Richmond, Cal., Street Work	Mar. 6
Apr. 3.	Santa Barbara, Cal., Bridge	Mar. 6
Apr. 24.	Buenos Aires, Argentina, Machinery	Feb. 28

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Construction News

STREET AND ROAD WORK

Alameda, Cal.—City engineer James Sutton is preparing plans for paving two blocks on Webster street.

Berkeley, Cal.—City engineer J. J. Jessup is preparing plans for paving Adeline street and Bancroft way.

Chehalis, Wash.—County engineer J. D. Neville has prepared plans for four miles of pavement in western part of county, and for three miles of 16-ft. concrete pavement on Pacific highway. Call for bids will soon be issued on this work. One mile of 8-ft. concrete pavement will be constructed by day labor near Adna.

Douglas, Ariz.—Contract for construction of pavement on several streets has been awarded to Warren Brother's Co. at $99,836.01. California-Arizona Construction Co. bid $101,116.99 and Toohey & Sons, $103,501.32.

Ephrata, Wash.—Bids will be received until March 7 by County Commissioners for construction of three permanent highways, total length 10 miles. Plans may be obtained from E. H. Strading, county engineer, upon deposit of $2 for each set.

Fresno, Cal.—Bids will be received until 5 p.m., March 6, by W. H. Ryan, city clerk, for the following street work: 2-in. bitulithic wearing surface on 5-in. concrete base and corrugated iron culverts on Santa Fe avenue and on Ventura avenue; 1½-in. warrenite surface on 2½-in. asphaltic concrete base and corrugated iron culverts on First street.

Lindsay, Cal.—Contract for paving five blocks on Honolulu street has been awarded to Worswick Street Paving Co., Union National Bank Bdg., Fresno.

Los Angeles, Cal.—Bids will be received until 10 a.m., March 6, by Board of Public Works for the following street work: grading and oiling, curbs, sidewalks, and concrete gutters on Westmoreland avenue; sidewalks, curbs, and granite-block gutters on Main street; asphalt pavement, curbs, granite-block gutters, and storm drains on Manhattan place.

Contract for improving 8th street has been awarded to California-Arizona Construction Co., 1700 East Washington street, for $2978.57.

Contract for improving Poinsettia place has been awarded to Bryant & Austin, Inc., 1650 Compton avenue, for $3402.95.

Contract for improving Cherry street has been awarded to Ford & Stout, Bradbury Bdg., for $4347.18.

Modesto, Cal.—Plans and specifications have been prepared by city engineer Freitas for construction of three blocks of topeka pavement on concrete base on McHenry avenue.

Oakland, Cal.—Bids will be received until noon, March 16, by L. W. Cummings, city clerk, for grading and construction of oil macadam pavement, redwood curbs, concrete gutters, corrugated iron and concrete culverts, brick storm-water inlets, and vitrified pipe conduits on 55th avenue.

Bids will also be received until same time for grading and construction of oiled macadam pavement, concrete curbs and gutters, and corrugated iron and concrete culverts on 100th avenue.

Contract for improving Capp street has been awarded to Hutchinson Co., 13th and Franklin streets, at 10c. per cu. yd. for grading, 10c. per lin. ft. for redwood curbs, 13c. per sq. ft. for concrete gutters, 8½c. per sq. ft. for oiled macadam pavement, and 10c. per sq. ft. for cement sidewalks.

Olympia, Wash.—Bids will be received until March 20 by W. R. Roy, State Highway Commissioner, for graveling 7½ miles of Pacific highway from Toledo southerly.

Contract for construction of ten miles of Sunset highway between Ellensburg and Vantage has been awarded by State Highway Commission to Martin Holm, Ellensburg, for $22,090.

Palo Alto, Cal.—City engineer J. F. Byxbee is preparing plans for concrete pavement with oiled screening surface on several streets.

Pasadena, Cal.—Bids will be received until 10 a.m., March 7, by H. Dyer, city clerk, for improving Howard place.

Pendleton, Ore.—Bond issue for construction of county highway system is proposed. County judge Charles Marsh is interested.

Pomona, Cal.—City Council is considering plan to make concrete highway in beds of Thompson creek. This creek carries flood-waters for a short time only during the year, and the rest of the time the pavement can be used as a highway. Pavement will be 22 ft. wide with 24-in. curbs, and the length will be three miles. Estimated cost is $75,000, which will be shared by city and county.

Portland, Ore.—Following bids have been received for paving Ainsworth avenue; bitulithic pavement on crushed-rock base, Oskar Huber, $1.25 per sq. yd.; Oregon Independent Paving Co., $1.25; Warren Construction Co., $1.85; sheet asphalt on concrete base, Warren Construction Co., $1.60; asphaltic concrete on concrete base, Warren Construction Co., $1.62.

Reno, Nev.—Plans are being prepared for grading and construction of macadam pavement and concrete curbs and gutters on Mill street.

Richmond, Cal.—City Council has decided to lay bitulithic pavement on 6-in. concrete base on 23rd street from Macdonald avenue to northern city limits. City clerk will receive bids until April 1.

City Council has decided to pave Bay street with topeka top on concrete base. H. D. Chapman is city engineer.

Ripon, Cal.—County surveyor F. E. Quail, Stockton, is preparing plans for improving Main street.

San Diego, Cal.—Citizens Committee has recommended bond issue to repair storm damage to highways as follows: construction of steel bridges on road from San Diego to Tia Juana, San Diego to Campo, El Cajon to Escondido; construction of concrete fords or temporary pile bridges on other roads; repair of roads through the county, new roads to be constructed only where old roads have been destroyed, and no hard-surfaced roads to be constructed at the present time.

San Francisco, Cal.—Grading and construction of pavement, sewers, concrete curbs, walls, and stairways on Sanchez street has been ordered.

San Jose, Cal.—Ransome-Crummey Co., First Savings Bank Bdg., Oakland, will construct six blocks of pavement on San Fernando street by private contract.

Santa Monica, Cal.—Contract for construction of Palisades road has been awarded to J. D. Kneen, Dudley Bdg., for $35,000.

Sausalito, Cal.—Bids will be received until about March 14 by city clerk for construction of pavement on Central avenue, West street, and North street. Leonard Hohl is city engineer.

South San Francisco, Cal.—Contract for construction of pavement on several streets has been awarded to D. O. Church Co., 68 Post street, San Francisco, for $36,938.

Sunnyvale, Cal.—Town engineer F. P. McCray is preparing plans for construction of pavement on several streets.

Whittier, Cal.—Contract for construction of topeka pavement on concrete base on Broadway has been awarded to California Arizona Construction Co., Los Angeles, for $8000.

SEWERS AND DRAINAGE

Butte City, Cal.—Contract for construction of a number of canals and drainage ditches on Washington Dodge ranch has been awarded to Peter Hoar, Durham.

Kalama, Wash.—County Commissioners will receive bids until March 7 for grading and draining two miles of Mt. Crawford road. R. C. Westwick is county engineer.

Los Angeles, Cal.—Board of Public Works will receive bids until 10 a.m., March 6, for construction of sewers on Baxter street, Mont Clair street, and Avenue 43.

Contract for construction of sewers on Gower street has been awarded to J. P. Glick, 460 Concord street.

Richmond, Cal.—City clerk will receive bids until March 13 for construction of sewers in Canal subdivision.

Sacramento, Cal.—Bids will be received until 11 a.m., March 9, by M. J. Desmond, city clerk, for construction of 8-in. sewer on Hollyhock avenue.

State Reclamation Board has levied assessment of $1,095,000 for construction of Sacramento by-pass. Max W. Enderlein, Hanford; F. C. Herrmann, Merchants Exchange Bdg., San Francisco; and B. A. Etcheverry, Berkeley, are assessors.

City engineer Frank C. Miller has recommended construction of sewers in district recently annexed to city.

San Jose, Cal.—Bids will be received until 5 p.m., March 6,

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by R. E. Walter, city clerk, for construction of sewer for one block on Washington street.

Stockton, Cal.—Bids will be received until 10:30 a.m., March 7, by G. W. Pulich, city clerk, for construction of concrete storm sewers from corner of Madison and North streets to Yosemite Lake pumping station.

Woodland, Cal.—Election will be held in May to vote on bond issue of $55,246 for extensions to sewers and water system. C. E. Arnold is city engineer.

BRIDGES AND CULVERTS

Boise, Ida.—Bids will be received until March 18 by State Highway Commission for construction of 301-ft. steel bridge across Malad river in Gooding county.

Chehalis, Wash.—County Commissioners will receive bids until March 11 for construction of steel bridge over Cowlitz river at Cora ferry. Estimated cost is $10,000. J. D. Neville is county engineer.

Helena, Mont.—Bids will be received until March 8 by G. R. Metlen, secretary State Highway Commission, for construction of an 85-ft. steel bridge at Wence.

Bids will also be received until March 9 for construction of two 210-ft. steel spans at St. Regis.

Bids will also be received until March 10 for construction of one 140-ft. and one 175-ft. steel span at Alberton.

Sand Point, Ida.—Plans of Spokane International railroad for bridge across Pend Oreille river have been approved by U. S. Engineer Corps.

Santa Ana, Cal.—Election has been called for May 3 to vote on bond issue for $150,000, $110,000 for construction of bridges in place of those washed out by recent storms, and $40,000 for repair of flood damage to highways. Most of the bridges to be constructed will be of concrete. S. H. Finley is engineer for County Highway Commission.

Santa Barbara, Cal.—Board of Supervisors will receive bids until 10 a.m., April 3, for construction of two reinforced concrete bridges on State highway over San Antonio creek. Plans from county clerk upon deposit of $10 for each set.

South Bend, Wash.—County Commissioners will receive bids until March 8 for construction of 60-ft. reinforced concrete bridge across Half Moon creek at Lebam, and for construction of 120-ft. steel bridge over Willapa river at East Raymond. Charles B. Nims is county engineer.

IRRIGATION AND WATER SUPPLY

Covina, Cal.—Bond issue of $106,000 for construction of municipal water system has been voted.

Doyle, Cal.—Elbert Howard, Doyle, has been elected president of the newly formed Southern Lassen irrigation district. John Mack, Calvena, is secretary and William Wales, Woodland, is engineer.

Los Angeles, Cal.—Bids will be received until 2 p.m., March 6, by Board of Supervisors for furnishing gate-valves for water system in San Fernando valley.

Contract for furnishing steel pipe in class No. 4 for water system in San Fernando valley has been awarded to Los Angeles Manufacturing Co., 2500 Leonard street, for $251,375. This comprised the following items: 672 ft. 18-in. pipe; 18,546 ft. 16-in.; 60,170 ft. 14-in.; 94,536 ft. 12-in.; and 163,186 ft. 8-in. pipe. All bids on classes No. 1, 2, and 3 were rejected.

Following bids were received for furnishing steel pipe for water-system in San Fernando valley: Baker Iron Works, class No. 1, $146,723; No. 2, $103,265; No. 3, $90,489; No. 4, $319,865; Lacy Manufacturing Co., No. 1, $142,787.50; No. 2, $97,119; No. 3, $84,257; No. 4, $322,784; Llewellyn Iron Works, No. 1, $140,-175; No. 2, $100,120; Western Pipe & Steel Co., No. 3, $89,925; No. 4, $319,168; Los Angeles Manufacturing Co., No. 4, $251,375.

Oroville, Cal.—Palermo Land & Water Co. will replace wooden flume across McCabe's creek with a galvanized iron structure.

Princeton, Cal.—Princeton-Codora-Glenn Water Users' Association has been formed to take over part of the system of the Sacramento Valley West Side Canal Co. District will contain 20,000 acres, and $160,000 is to be paid for system. J. F. Mallon is interested.

St. Ignatius, Mont.—Bids will be received until 2 p.m., March 29, at office of U. S. Reclamation Service, for construction of canals and structures on the Flathead project. Work includes 3500 cu. yd. excavation, 250 cu. yd. reinforced concrete, 900 sq. yd. paving, laying 1300 ft. vitrified pipe, erecting 16,000 ft. B.M. lumber, and placing 31,500 lb. structural and reinforcing steel. Work is from two to eight miles southeast of Arlee, on the Northern Pacific railroad. Particulars from U. S. Reclamation Service, Washington, D. C., Denver, Colorado, or St. Ignatius.

Salt Lake City, Utah.—Bids will be received until 10 a.m., March 15, by Gordon Snow, city recorder, for construction of water-mains on several streets. Estimated cost is $70,000. Plans from S. Q. Cannon, city engineer, upon deposit of $5.

Contract for cleaning five miles of water-mains has been awarded to National Water Main Cleaning Co., at 23c. per ft. for 4, 6, and 8-in. pipe, and 32c. per ft. for 12-in. pipe.

San Diego, Cal.—Election has been called for March 31 to vote on the following questions: diversion of $100,000 bond money from development fund of San Diego river to construction of Upper Otay-Lower Otay pipe-line, and Dulzura-Upper Otay pipe-line; diversion of $75,000 from reservoir fund for reconstruction of Chollas and Bonita pipe-lines, including bridges and restoration of Mission Valley pumping plants and wells; issue of $100,000 of new bonds for restoring Dulzura concrete conduit.

City manager F. M. Lockwood is preparing plans for conduit from Dulzura creek to Upper Otay dam, about six miles. A 48-in. wood-stave pipe will probably be used.

Santa Maria, Cal.—Bond issue of $72,000 for purchase of water system has been voted.

Seattle, Wash.—United States Engineers have recommended expenditure of $657,000 for completion of Lake Washington canal, to be used for dredging the canal to deep water, about one mile, and for concrete revetment on canal banks.

Sequim, Wash.—Contract for construction of 7½ miles of canals for Highland irrigation district has been awarded to McDonald & Jones, Globe Block, Seattle, for $18,353.73. Engineer's estimate was $20,563.33.

Sunnyvale, Cal.—Purchase of booster pump for water works is proposed. F. P. McCray is town engineer.

Washington, D. C.—Bids will be received until 2 p.m., March 8, at office of U. S. Reclamation Sarvice for furnishing two pressure pumps, each of 30 gallons capacity per minute.

Yoncalla, Ore.—Election has been called for April 17 to vote on bond issue of $20,000 for construction of water-system.

LIGHT, HEAT, AND POWER

Florence, Ariz.—Election has been called for March 11 to vote on bond issue of $50,000 for construction of electric-lighting system and water system.

Fresno, Cal.—Bids will be received until 5 p.m., March 6, by W. H. Ryan, city clerk, for construction of electrolier lighting system on several streets.

Reno, Nev.—Construction of electrolier lighting system in business district has been proposed. Estimated cost is $5000.

Richmond, Cal.—Pacific Gas & Electric Co. will lay new high-pressure gas main from Berkeley to Richmond. Estimated cost is $50,000. W. E. Luce is local manager.

Yreka, Cal.—California-Oregon Power Co. will raise storage dam at Copco.

BUILDING CONSTRUCTION

Grass Valley, Cal.—Bids will be received until March 17 by Board of Library Trustees for construction of $15,000 library. William Mooser, Nevada Bank Bdg., San Francisco, is architect.

Kingman, Ariz.—Contract for construction of reinforced concrete addition to Beale hotel has been awarded to Albrecht Anderson, Phoenix, for $32,358.

Merced, Cal.—Bond issue of $150,000 for construction of building for high school has been proposed.

Pasadena, Cal.—Contract for construction of $65,000 reinforced concrete building for Throop Institute of Technology has been awarded to Frank Graves & Son, Builders Exchange, Los Angeles.

Porterville, Cal.—B. E. Remmel is preparing plans for $50,000 theatre building to be erected for Mrs. E. H. Williams.

Portland, Ore.—General contract for construction of municipal auditorium has been awarded to Hans Pederson, Madison Block, Seattle, for $320,262. Contract for plumbing has been awarded to Rushlight & Hastorf, 354 Hawthorne street, for $27,877.

Sacramento, Cal.—McLeran & Peterson, Sharon Bdg., San

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Francisco, were low bidders at $23,950 for construction of women's building at agricultural fair grounds.

Salt Lake City, Utah.—Bond issue of $200,000 for construction of school buildings has been voted.

San Bernardino, Cal.—Bids will be received until 11 a.m. March 20, by Board of Supervisors for construction of county hospital buildings. This is the second time this work has been advertised. The first time all bids were considerably in excess of the $97,000 available. Contracts will not be awarded for more buildings than can be constructed for the amount available.

Tacoma, Wash.—Bids will be received until 4 p.m., March 22, by Board of Directors, Tacoma school district, Central School Bdg., for construction of high-school gymnasium.

Walla Walla, Wash.—Osterman & Siebert, Drumheiler Bdg., have completed plans for addition to high school costing $139,000 and for grammar school costing $60,000, and calls for bids will be issued soon. N. Higgins is president of school board.

MISCELLANEOUS

Colfax, Wash.—Bids will be received until 11 a.m., March 20, by A. R. Metz, county auditor, for furnishing an asphalt pressure road-oiler, new or second-hand.

Fresno, Cal.—Bids will be received until 9 p.m., March 20, by W. H. Ryan, city clerk, for disposal of garbage.

Grants, Utah.—Diamond Match Co. will construct $50,000 plant for extracting potash from waters of Great Salt Lake.

Los Angeles, Cal.—Bids will be received until 2 p.m., March 6, by Supervisors for furnishing motor trucks for construction of water system in San Fernando valley.

Bids will be received until 10:30 a.m., March 8, by C. H. Matson, secretary Board of Harbor Commissioners, for furnishing creosoted material for wharf No. 152.

Bids will be received until 10:30 a.m., March 8, by Board of Harbor Commissioners for dredging and filling at Smith's island.

Bids will be received until 4 p.m., March 3, by J. P. Vroman, secretary Department of Public Service, 506 Knickerbocker Bdg., for furnishing a concrete mixing and distributing system.

Board of Harbor Commissioners will receive bids until 10:30 a.m., March 15, for furnishing hoists for warehouse No. 1.

Niles, Cal.—Subway under Southern Pacific tracks will be constructed on State highway. Estimated cost is $33,000, which will be shared by the company and by Alameda county.

Oroville, Cal.—Construction of concrete swimming tank is proposed. Estimated cost is $2500. F. A. Egan is interested.

Portland, Ore.—Contract for repairing U. S. dredge 'Chinook' has been awarded to William Cornfoot, 28 Albina avenue, for $26,384.

Richmond, Cal.—General Roofing Co. will construct plant. Estimated cost is $750,000.

Sacramento, Cal.—Bids will be received until 11 a.m., March 9, by M. J. Desmond, city clerk, for furnishing one motor-driven combined flusher and sprinkler with a tank of 1200 gallons capacity.

Salt Lake City, Utah.—Mountain States Telephone & Telegraph Co. will spend $90,000 on improvements in Holliday district.

San Francisco, Cal.—Contract for reconstruction of pier No. 11, which will replace the present pier No. 13, has been awarded by Board of Harbor Commissioners to Healy-Tibbitts Construction Co., Main and Market streets, for $99,317.

Santa Monica, Cal.—C. I. D. Loof, Long Beach, will construct 700-ft. amusement pier.

Seattle, Wash.—Contract for construction of West Seattle ferry-boat has been awarded to J. F. Duthie Co., 2917 Whatcom street, for $29,435.

Walla Walla, Wash.—Bids will be received until March 20 by M. A. Power, city clerk, for furnishing 1000 ft. of 2½-in. cotton-covered rubber-line fire-hose.

Washington, D. C.—Bureau of Yards and Docks, Navy Department, will receive bids until 11 a.m., March 11, for furnishing three locomotive cranes at Mare Island, Cal. Particulars from Purchasing Pay Officer, U. S. Navy Pay Office, San Francisco.

Bureau of Supplies and Accounts, Navy Department, will receive bids until March 21 for furnishing the following at Mare Island, Cal.: 7000 ft. wash-deck hose, schedule 9348; two cargo oil-pumps, schedule 9334; 18 sets auger bits, 1200 padlocks, miscellaneous quantity twist drills, pliers, saws, wood-screws, brass machine-screws, vises, and wrenches, schedule 9349. Particulars from Purchasing Pay Officer, U. S. Navy Pay Office, San Francisco.

Some New Books on Timely Subjects

CIVIL ENGINEERING

MANUAL OF SURVEYING FOR FIELD AND OFFICE. By Raymond E. Davis, C.E. 395 pages, pocket size, 54 illustrations, 15 tables. Price, $2.50.

PLAIN AND REINFORCED CONCRETE ARCHES. By J. Melan. Translated by D. B. Steinman. 153 pages. Index. Price, $2.

STRUCTURAL STEEL DRAFTING AND ELEMENTARY DESIGN. By Charles D. Conklin, Jr. 151 pages. Index. Price, $2.50.

SURVEYING MANUAL. By William D. Pence and Milo S. Ketchum. 388 pages, including 131 pages of tables. Illustrated. Morocco. Price, $2.

WORKING DATA FOR IRRIGATION ENGINEERS. By E. A. Moritz. 388 pages. Index. Price, 4.

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DIESEL ENGINES. By A. H. Goldingham. 206 pages, with many illustrations, half-tone and folding plates. Cloth. Price, $3.

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MISCELLANEOUS

IRRIGATION PRACTICE AND ENGINEERING. By B. A. Etcheverry. Vol. I—Use of Irrigation Water and Irrigation Practice. 213 pages. 103 illustrations. Price, $2. Vol. II—Conveyance of Water. 364 pages. 82 illustrations. 60 pages of inserts. Price, $3.50. Vol. III—Irrigation Structures and Distribution System. 438 pages. 186 illustrations. 40 pages of inserts. Price, 4.

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